UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1997

SUMMER RESEARCH PROGRAM FINAL REPORTS

VOLUME 1

RESEARCH & DEVELOPMENT LABORATORIES

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13. ABSTRACT *(Maximum 200 words)*

The United States Air Force Summer Research Program (USAF-SRP) is designed to introduce university, college, and technical institute faculty members, graduate students, and high school students to Air Force research. This is accomplished by the faculty members (Summer Faculty Research Program (SFRP)), graduate students (Graduate Student Research Program (GSRP)), and high school students (High School Apprenticeship Program (HSAP)) being selected on a nationally advertised competitive basis during the summer intersession period to perform research at Air Force Research Laboratory (AFRL) Technical Directorates, Air Force Air Logistics Centers (ALC), and other AF Laboratories. The management volume consists of a program overview, program management statistics, a listing of the participants, and an abstract for each participants summer research.

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PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

Due to its length, Volume 4 is bound in two parts, 4A and 4B. Volume 4A contains #1-18. Volume 4B contains reports #19-31. The Table of Contents for Volume 4 is included in both parts.

This document is one of a set of 16 volumes describing the 1997 AFOSR Summer Research Program. The following volumes comprise the set:

VOLUME	TITLE
1	Program Management Report
	Summer Faculty Research Program (SFRP) Reports
2A & 2B	Armstrong Laboratory
3A & 3B	Phillips Laboratory
4A & 4B	Rome Laboratory
5A , 5B & 5C	Wright Laboratory
6	Arnold Engineering Development Center, United States Air Force Academy and Air Logistics Centers
	Graduate Student Research Program (GSRP) Reports
7A & 7B	Armstrong Laboratory
8	Phillips Laboratory
9	Rome Laboratory
10A & 10B	Wright Laboratory
11	Arnold Engineering Development Center, United States Air Force Academy, Wilford Hall Medical Center and Air Logistics Centers
	High School Apprenticeship Program (HSAP) Reports
12A & 12B	Armstrong Laboratory
13	Phillips Laboratory
14	Rome Laboratory
15B&15B	Wright Laboratory
16	Arnold Engineering Development Center

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1. INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty, graduate students, and high school students to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines using laboratory facilities and equipment not often available at associates' institutions.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members with at least two years of teaching and/or research experience in accredited U.S. colleges, universities, or technical institutions. SFRP associates must be either U.S. citizens or permanent residents.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or a master's degree; GSRP associates must be U.S. citizens enrolled full time at an accredited institution.

The High School Apprentice Program (HSAP) annually selects about 125 high school students located within a twenty mile commuting distance of participating Air Force laboratories.

AFOSR also offers its research associates an opportunity, under the Summer Research Extension Program (SREP), to continue their AFOSR-sponsored research at their home institutions through the award of research grants. In 1994 the maximum amount of each grant was increased from $20,000 to $25,000, and the number of AFOSR-sponsored grants decreased from 75 to 60. A separate annual report is compiled on the SREP.

The numbers of projected summer research participants in each of the three categories and SREP "grants" are usually increased through direct sponsorship by participating laboratories.

AFOSR's SRP has well served its objectives of building critical links between Air Force research laboratories and the academic community, opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest, and strengthening the nation's efforts to sustain careers in science and engineering. The success of the SRP can be gauged from its growth from inception (see Table 1) and from the favorable responses the 1997 participants expressed in end-of-tour SRP evaluations (Appendix B).

AFOSR contracts for administration of the SRP by civilian contractors. The contract was first awarded to Research & Development Laboratories (RDL) in September 1990. After completion of the

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1990 contract, RDL (in 1993) won the recompetition for the basic year and four 1-year options.

2. PARTICIPATION IN THE SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the number of associates in the program each year.

YEAR	SRP Participation, by Year			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444
1992	185	121	159	464
1993	187	117	136	440
1994	192	117	133	442
1995	190	115	137	442
1996	188	109	138	435
1997	148	98	140	427

Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years. Since then, the number of funded positions has remained fairly constant at a slightly lower level.

3.   RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 52-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous individual requesters (over 1000 annually).

RDL placed advertisements in the following publications: *Black Issues in Higher Education, Winds of Change,* and *IEEE Spectrum.* Because no participants list either *Physics Today* or *Chemical & Engineering News* as being their source of learning about the program for the past several years, advertisements in these magazines were dropped, and the funds were used to cover increases in brochure printing costs.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants   and   participants   for   1997   are   shown   in   this   table.

1997 Applicants and Participants			
PARTICIPANT CATEGORY	TOTAL APPLICANTS	SELECTEES	DECLINING SELECTEES
SFRP	490	188	32
(HBCU/MI)	(0)	(0)	(0)
GSRP	202	98	9
(HBCU/MI)	(0)	(0)	(0)
HSAP	433	140	14
TOTAL	1125	426	55

4.   SITE VISITS

During June and July of 1997, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5.   HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

Before 1993, an RDL program representative visited from seven to ten different HBCU/MIs annually to promote interest in the SRP among the faculty and graduate students. These efforts were marginally effective, yielding a doubling of HBCI/MI applicants. In an effort to achieve AFOSR's goal of 10% of all applicants and selectees being HBCU/MI qualified, the RDL team decided to try other avenues of approach to increase the number of qualified applicants. Through the combined efforts of the AFOSR Program Office at Bolling AFB and RDL, two very active minority groups were found, HACU (Hispanic American Colleges and Universities) and AISES (American Indian Science and Engineering Society). RDL is in communication with representatives of each of these organizations on a monthly basis to keep up with the their activities and special events. Both organizations have widely-distributed magazines/quarterlies in which RDL placed ads.

Since 1994 the number of both SFRP and GSRP HBCU/MI applicants and participants has increased ten-fold, from about two dozen SFRP applicants and a half dozen selectees to over 100 applicants and two dozen selectees, and a half-dozen GSRP applicants and two or three selectees to 18 applicants and 7 or 8 selectees. Since 1993, the SFRP had a two-fold applicant increase and a two-fold selectee increase. Since 1993, the GSRP had a three-fold applicant increase and a three to four-fold increase in selectees.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates. This year, 5 HBCU/MI SFRPs declined after they were selected (and there was no one qualified to replace them with). The following table records HBCU/MI participation in this program.

SRP HBCU/MI Participation, By Year				
YEAR	SFRP		GSRP	
	Applicants	Participants	Applicants	Participants
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6
1995	90	21	20	8
1996	119	27	18	7

6. SRP FUNDING SOURCES

Funding sources for the 1997 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1997 SRP selected participants are shown here.

1997 SRP FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	141	89	123
USAF Laboratory Funds	48	9	17
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	0	0	N/A
TOTAL	9	98	140

SFRP - 188 were selected, but thirty two canceled too late to be replaced.
GSRP - 98 were selected, but nine canceled too late to be replaced.
HSAP - 140 were selected, but fourteen canceled too late to be replaced.

7.   COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

1997 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994	1995	1996	1997
Faculty Members	$690	$718	$740	$740	$740	$770	$770
Graduate Student (Master's Degree)	$425	$442	$455	$455	$455	$470	$470
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391	$391	$400	$400
High School Student (First Year)	$200	$200	$200	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $50/day for faculty and $40/day for graduate students. Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and GSRP associates, 65 % (194 out of 286) claimed travel reimbursements at an average round-trip cost of $776.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-three percent (85 out of 188) of faculty associates took orientation trips at an average cost of $388. By contrast, in 1993, 58 % of SFRP associates took

orientation visits at an average cost of $685; that was the highest percentage of associates opting to take an orientation trip since RDL has administered the SRP, and the highest average cost of an orientation trip. These 1993 numbers are included to show the fluctuation which can occur in these numbers for planning purposes.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

This is the second year of using direct deposit for the SFRP and GSRP associates. The process went much more smoothly with respect to obtaining required information from the associates, only 7% of the associates' information needed clarification in order for direct deposit to properly function as opposed to 10% from last year. The remaining associates received their stipend and expense payments via checks sent in the US mail.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8.   CONTENTS OF THE 1997 REPORT

The complete set of reports for the 1997 SRP includes this program management report (Volume 1) augmented by fifteen volumes of final research reports by the 1997 associates, as indicated below:

1997 SRP Final Report Volume Assignments

LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, ALCs, WHMC	6	11	16

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APPENDIX A -- PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP associates represented 169 different colleges, universities, and institutions, GSRP associates represented 95 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 47 states plus Washington D.C. Selectees represent 44 states.

GSRP - Applicants came from 44 states. Selectees represent 32 states.

HSAP - Applicants came from thirteen states. Selectees represent nine states.

Total Number of Participants	
SFRP	189
GSRP	97
HSAP	140
TOTAL	426

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	184	0	184
Master's	2	41	43
Bachelor's	0	56	56
TOTAL	186	97	298

SFRP Academic Titles	
Assistant Professor	64
Associate Professor	70
Professor	40
Instructor	0
Chairman	1
Visiting Professor	1
Visiting Assoc. Prof.	1
Research Associate	9
TOTAL	186

Source of Learning About the SRP		
Category	Applicants	Selectees
Applied/participated in prior years	28%	34%
Colleague familiar with SRP	19%	16%
Brochure mailed to institution	23%	17%
Contact with Air Force laboratory	17%	23%
IEEE Spectrum	2%	1%
BIIHE	1%	1%
Other source	10%	8%
TOTAL	100%	100%

APPENDIX B -- SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	275
HSAPs	113
USAF Laboratory Focal Points	84
USAF Laboratory HSAP Mentors	6

All groups indicate unanimous enthusiasm for the SRP experience.

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below:

A.   Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B.   Faculty Associates suggest higher stipends for SFRP associates.

C.   Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same argument was used to raise the faculty and graduate student participation time a few years ago.)

2. 1997 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 84 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ?								(% Response)			
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	Evals Recv'd	0	1	2	3+	0	1	2	3+	0	1	2	3+
AEDC	0	-	-	-	-	-	-	-	-	-	-	-	-
WHMC	0	-	-	-	-	-	-	-	-	-	-	-	-
AL	7	28	28	28	14	54	14	28	0	86	0	14	0
USAFA	1	0	100	0	0	100	0	0	0	0	100	0	0
PL	25	40	40	16	4	88	12	0	0	84	12	4	0
RL	5	60	40	0	0	80	10	0	0	100	0	0	0
WL	46	30	43	20	6	78	17	4	0	93	4	2	0
Total	84	32%	50%	13%	5%	80%	11%	6%	0%	73%	23%	4%	0%

LFP Evaluation Summary. The summarized responses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
    a. Time available for evaluation of applications:
    b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5   a. Benefits of associate's work to laboratory:
    b. Benefits of associate's work to Air Force:
6.   a. Enhancement of research qualifications for LFP and staff:
    b. Enhancement of research qualifications for SFRP associate:
    c. Enhancement of research qualifications for GSRP associate:
7.   a. Enhancement of knowledge for LFP and staff:
    b. Enhancement of knowledge for SFRP associate:
    c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10.   a. Your working relationship with SFRP:
    b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

12. Quality of program literature for associate:
13.   a. Quality of RDL's communications with you:
        b. Quality of RDL's communications with associates:
14. Overall assessment of SRP:

Table B-3. Laboratory Focal Point Reponses to above questions

	AEDC	AL	USAFA	PL	RL	WHMC	WL
# Evals Recv'd	0	7	1	14	5	0	46
Question #							
2	-	86 %	0 %	88 %	80 %	-	85 %
2a	-	4.3	n/a	3.8	4.0	-	3.6
2b	-	4.0	n/a	3.9	4.5	-	4.1
3	-	4.5	n/a	4.3	4.3	-	3.7
4	-	4.1	4.0	4.1	4.2	-	3.9
5a	-	4.3	5.0	4.3	4.6	-	4.4
5b	-	4.5	n/a	4.2	4.6	-	4.3
6a	-	4.5	5.0	4.0	4.4	-	4.3
6b	-	4.3	n/a	4.1	5.0	-	4.4
6c	-	3.7	5.0	3.5	5.0	-	4.3
7a	-	4.7	5.0	4.0	4.4	-	4.3
7b	-	4.3	n/a	4.2	5.0	-	4.4
7c	-	4.0	5.0	3.9	5.0	-	4.3
8	-	4.6	4.0	4.5	4.6	-	4.3
9	-	4.9	5.0	4.4	4.8	-	4.2
10a	-	5.0	n/a	4.6	4.6	-	4.6
10b	-	4.7	5.0	3.9	5.0	-	4.4
11	-	4.6	5.0	4.4	4.8	-	4.4
12	-	4.0	4.0	4.0	4.2	-	3.8
13a	-	3.2	4.0	3.5	3.8	-	3.4
13b	-	3.4	4.0	3.6	4.5	-	3.6
14	-	4.4	5.0	4.4	4.8	-	4.4

3. 1997 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 257 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from 1 (below average) to 5 (above average) - by Air Force base results and over-all results of the 1997 evaluations are listed after the questions.

1. The match between the laboratories research and your field:
2. Your working relationship with your LFP:
3. Enhancement of your academic qualifications:
4. Enhancement of your research qualifications:
5. Lab readiness for you: LFP, task, plan:
6. Lab readiness for you: equipment, supplies, facilities:
7. Lab resources:
8. Lab research and administrative support:
9. Adequacy of brochure and associate handbook:
10. RDL communications with you:
11. Overall payment procedures:
12. Overall assessment of the SRP:
13.   a. Would you apply again?
            b. Will you continue this or related research?
14. Was length of your tour satisfactory?
15. Percentage of associates who experienced difficulties in finding housing:
16. Where did you stay during your SRP tour?
        a.   At Home:
        b.   With Friend:
        c.   On Local Economy:
        d.   Base Quarters:
17. Value of orientation visit:
        a.   Essential:
        b.   Convenient:
        c.   Not Worth Cost:
        d.   Not Used:

SFRP and GSRP associate's responses are listed in tabular format on the following page.

Table B-4. 1997 SFRP & GSRP Associate Responses to SRP Evaluation

	Arnold	Brooks	Edwards	Eglin	Griffis	Hanscom	Kelly	Kirtland	Lackland	Robins	Tyndall	WPAFB	average
# res	6	48	6	14	31	19	3	32	1	2	10	85	257
1	4.8	4.4	4.6	4.7	4.4	4.9	4.6	4.6	5.0	5.0	4.0	4.7	4.6
2	5.0	4.6	4.1	4.9	4.7	4.7	5.0	4.7	5.0	5.0	4.6	4.8	4.7
3	4.5	4.4	4.0	4.6	4.3	4.2	4.3	4.4	5.0	5.0	4.5	4.3	4.4
4	4.3	4.5	3.8	4.6	4.4	4.4	4.3	4.6	5.0	4.0	4.4	4.5	4.5
5	4.5	4.3	3.3	4.8	4.4	4.5	4.3	4.2	5.0	5.0	3.9	4.4	4.4
6	4.3	4.3	3.7	4.7	4.4	4.5	4.0	3.8	5.0	5.0	3.8	4.2	4.2
7	4.5	4.4	4.2	4.8	4.5	4.3	4.3	4.1	5.0	5.0	4.3	4.3	4.4
8	4.5	4.6	3.0	4.9	4.4	4.3	4.3	4.5	5.0	5.0	4.7	4.5	4.5
9	4.7	4.5	4.7	4.5	4.3	4.5	4.7	4.3	5.0	5.0	4.1	4.5	4.5
10	4.2	4.4	4.7	4.4	4.1	4.1	4.0	4.2	5.0	4.5	3.6	4.4	4.3
11	3.8	4.1	4.5	4.0	3.9	4.1	4.0	4.0	3.0	4.0	3.7	4.0	4.0
12	5.7	4.7	4.3	4.9	4.5	4.9	4.7	4.6	5.0	4.5	4.6	4.5	4.6
Numbers below are percentages													
13a	83	90	83	93	87	75	100	81	100	100	100	86	87
13b	100	89	83	100	94	98	100	94	100	100	100	94	93
14	83	96	100	90	87	80	100	92	100	100	70	84	88
15	17	6	0	33	20	76	33	25	0	100	20	8	39
16a	-	26	17	9	38	23	33	4	-	-	-	30	
16b	100	33	-	40	-	8	-	-	-	-	36	2	
16c	-	41	83	40	62	69	67	96	100	100	64	68	
16d	-	-	-	-	-	-	-	-	-	-	-	0	
17a	-	33	100	17	50	14	67	39	-	50	40	31	35
17b	-	21	-	17	10	14	-	24	-	50	20	16	16
17c	-	-	-	-	10	7	-	-	-	-	-	2	3
17d	100	46	-	66	30	69	33	37	100	-	40	51	46

4. 1997 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

Not enough evaluations received (5 total) from Mentors to do useful summary.

5. 1997 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 113 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from
1 (below average) to 5 (above average)

1. Your influence on selection of topic/type of work.
2. Working relationship with mentor, other lab scientists.
3. Enhancement of your academic qualifications.
4. Technically challenging work.
5. Lab readiness for you: mentor, task, work plan, equipment.
6. Influence on your career.
7. Increased interest in math/science.
8. Lab research & administrative support.
9. Adequacy of RDL's Apprentice Handbook and administrative materials.
10. Responsiveness of RDL communications.
11. Overall payment procedures.
12. Overall assessment of SRP value to you.
13. Would you apply again next year?   Yes (92 %)
14. Will you pursue future studies related to this research?   Yes (68 %)
15. Was Tour length satisfactory?   Yes (82 %)

	Arnold	Brooks	Edwards	Eglin	Griffiss	Hanscom	Kirtland	Tyndall	WPAFB	Totals
# resp	5	19	7	15	13	2	7	5	40	113
1	2.8	3.3	3.4	3.5	3.4	4.0	3.2	3.6	3.6	3.4
2	4.4	4.6	4.5	4.8	4.6	4.0	4.4	4.0	4.6	4.6
3	4.0	4.2	4.1	4.3	4.5	5.0	4.3	4.6	4.4	4.4
4	3.6	3.9	4.0	4.5	4.2	5.0	4.6	3.8	4.3	4.2
5	4.4	4.1	3.7	4.5	4.1	3.0	3.9	3.6	3.9	4.0
6	3.2	3.6	3.6	4.1	3.8	5.0	3.3	3.8	3.6	3.7
7	2.8	4.1	4.0	3.9	3.9	5.0	3.6	4.0	4.0	3.9
8	3.8	4.1	4.0	4.3	4.0	4.0	4.3	3.8	4.3	4.2
9	4.4	3.6	4.1	4.1	3.5	4.0	3.9	4.0	3.7	3.8
10	4.0	3.8	4.1	3.7	4.1	4.0	3.9	2.4	3.8	3.8
11	4.2	4.2	3.7	3.9	3.8	3.0	3.7	2.6	3.7	3.8
12	4.0	4.5	4.9	4.6	4.6	5.0	4.6	4.2	4.3	4.5
Numbers below are percentages										
13	60%	95%	100%	100%	85%	100%	100%	100%	90%	92%
14	20%	80%	71%	80%	54%	100%	71%	80%	65%	68%
15	100%	70%	71%	100%	100%	50%	86%	60%	80%	82%

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              ALC/SA
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McFarland, Michael
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Laboratory: OO-ALC
              ALC/OO
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Laboratory: Arnold Engineering Development
              AEDC/EA
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Laboratory: Wright Laboratory
              WL/MN
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Laboratory: Arnold Engineering Development
              AEDC/EA
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Laboratory: Wright Laboratory
              WL/FI
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Laboratory: Armstrong Laboratory
              AL/EQ
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Laboratory: Armstrong Laboratory
              AL/CF
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Laboratory: Wright Laboratory
              WL/ML
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Laboratory: Phillips Laboratory
            PL/LI
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Laboratory: Armstrong Laboratory
            AL/AO
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Laboratory: Rome Laboratory
            RL/ER
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            AL/CF
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Laboratory: Wright Laboratory
            WL/ML
Vol-Page No: 5-52

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Laboratory: Rome Laboratory
            RL/OC
Vol-Page No: 4-21

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Laboratory: Wright Laboratory
            WL/FI
Vol-Page No: 5-53

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Laboratory: Rome Laboratory
            RL/CA
Vol-Page No: 4-22

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             WL/ML
Vol-Page No: 5-54

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Laboratory: Armstrong Laboratory
             AL/AO
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Laboratory: Rome Laboratory
             RL/C3
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Laboratory: Wright Laboratory
             WL/ML
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Laboratory: Rome Laboratory
             RL/IW
Vol-Page No: 4-24

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Laboratory: Wright Laboratory
             WL/PO
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Laboratory: Phillips Laboratory
             PL/VT
Vol-Page No: 3-27

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Laboratory: SM-ALC
             ALC/SM
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Laboratory: Armstrong Laboratory
             AL/EQ
Vol-Page No: 2-29

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Laboratory: Armstrong Laboratory
              AL/CF
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Laboratory: Armstrong Laboratory
              AL/AO
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Reynolds, David
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Laboratory: Armstrong Laboratory
              AL/CF
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Rizki, Mateen
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Field: Computer Science
Laboratory: Wright Laboratory
              WL/AA
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Roach, Robert
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Laboratory: Arnold Engineering Development
              AEDC/EA
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Laboratory: Phillips Laboratory
              PL/GP
Vol-Page No: 3-28

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Laboratory: Rome Laboratory
              RL/OC
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Laboratory: OO-ALC
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Laboratory: Rome Laboratory
              RL/C3
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              WL/ML
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Laboratory: Rome Laboratory
            RL/IR
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Laboratory: Wright Laboratory
            WL/ML
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Selvam, Rathinam
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Laboratory: Wright Laboratory
            WL/FI
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Laboratory: Wright Laboratory
            WL/FI
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Laboratory: Armstrong Laboratory
            AL/EQ
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Laboratory: Phillips Laboratory
            PL/RK
Vol-Page No: 3-29

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Laboratory: Wright Laboratory
            WL/AA
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            AL/CF
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Laboratory: Rome Laboratory
            RL/IR
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            RL/CA
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            WL/MN
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            WL/ML
Vol-Page No: 5-63

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Laboratory: Wright Laboratory
            WL/MN
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Laboratory: Wright Laboratory
            WL/AA
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Laboratory: Wright Laboratory
            WL/FI
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Trueblood, Max
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Laboratory: Wright Laboratory
            WL/PO
Vol-Page No: 5-67

Tsai, Chi-Tay
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Laboratory: Wright Laboratory
            WL/AA
Vol-Page No: 5-68

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Laboratory: Rome Laboratory
            RL/C3
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Laboratory: Wright Laboratory
            WL/FI
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Laboratory: OC-ALC
            ALC/OC
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Laboratory: Armstrong Laboratory
             AL/CF
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Laboratory: Arnold Engineering Development
             AEDC/EA
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Laboratory: Armstrong Laboratory
             AL/HR
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Laboratory: Wright Laboratory
             WL/PO
Vol-Page No: 5-70

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Laboratory: Phillips Laboratory
             PL/RK
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Laboratory: Rome Laboratory
             RL/CA
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Laboratory: Wright Laboratory
             WL/FI
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Laboratory: OC-ALC
             ALC/OC
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Laboratory: Armstrong Laboratory
             AL/CF
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Laboratory: Rome Laboratory
            RL/C3
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            WL/MN
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Laboratory: Rome Laboratory
            RL/IR
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Laboratory: Armstrong Laboratory
            AL/AO
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            AL/HR
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Laboratory: Wright Laboratory
            WL/MN
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Laboratory: Phillips Laboratory
            PL/LI
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Laboratory: Wright Laboratory
            WL/PO
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            AL/OE
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            WL/FI
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            AL/CF
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            WL/FI
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PL/WS
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PL/LI
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AL/AO
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PL/GP
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             PL/GP
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             AL/AO
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Laboratory: Wright Laboratory
             WL/ML
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Laboratory: Wright Laboratory
             WL/FI
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             AL/HR
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             AL/HR
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             AL/CF
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            AL/OE
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            PL/RK
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TEMPORAL AND SPATIAL CHARACTERISATION OF A SYNCHRONOUSLY-PUMPED PERIODICALLY-POLED LITHIUM NIOBATE OPTICAL PARAMETRIC OSCILLATOR

Graham R. Allan

Abstract

The successful operation and characterisation of a synchronously pumped optical parametric oscillator is reported. The OPO uses an optically pumped (cw-modelocked Nd:YAG laser) 5 cm crystal of periodically-poled lithium niobate in a temperature stabalised oven. The OPO produces pulses of ~100 ps duration in the wavelength range of ~1.5μm. Anomalous switching behaviour has been observed when the system is near synchronism and a reduction in the transmitted pump noise is seen for incident powers around threshold. Strong pump depletionwas observed in both the spatial and temporal profiles of the pump. Parasitic losses in the signal involving mixing and second harmonic generation were observed.

ATMOSPHERIC REACTIONS OF VOLATILE PAINT COMPONENTS: A MODELING APPROACH

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Abstract

In order to determine effective air pollution control strategies, the reactions of pollutants must be known. The primary mechanism of destruction for oxygenated compounds in the atmosphere is reaction with hydroxyl radicals. In the presence of oxygen and NO, these radicals form alkoxy radicals. To predict the yields of stable products from the reactions of organics, one must be able to accurately estimate the relative importance of the decomposition, isomerization, and O_2 reaction pathways of these alkoxy radicals. The work presented examines the decomposition and O_2 reaction pathways for alkoxy radicals of the general type, $R_1-O-C(O)-R_2$. Experimental yields for the OH initiated photooxidation of selected oxygenated compounds that are typically used in Air Force operations were compared to yields predicted from computer based chemical modeling. New estimates for the rate constants for the decomposition and O_2 reaction pathways for alkoxy radicals of the general form $R_1-O-C(O)-R_2$ have been determined to be 2.2×10^4 s^{-1} and 4.6×10^{-16} cm^{3}molecule^{-1} s^{-1}, respectively. These new rate constant estimates will allow Air Force personnel to accurately assess the air quality impacts of operations involving oxygenated compounds.

NOVEL ELECTROCHEMILUMINESCENCE REACTIONS
AND INSTRUMENTATION

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Abstract

A number of compounds whose structure indicated that they might bind to cations were screened for their electrochemiluminescence (ECL) properties. Screening was carried out in the presence of tripropylamine as a co-reactant. The organic compounds were screened both with and without a cation present by using a batch ECL instrument in two modes, solution and bead capture.

The three compounds which showed a large increase in ECL in the presence of cadmium ions were examined further. Conditions for the ECL reaction were optimised and a calibration graph for cadmium constructed. Limits of detection for cadmium were found to be in the low parts per billion region.

An ECL system which operates in both stop-flow and flow-through modes was constructed. A data acquisition program for acquisition of both the electrode voltage and photomultiplier tube output was written. A preliminary characterisation of the home-built flow-through ECL system was carried out using tris(2,2'-bipyridyl)ruthenium(II), a well known electrochemiluminescent compound.

PROPERTIES OF QUANTUM WELLS FORMED IN AlGaN/GaN HETEROSTRUCTURES

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Abstract

Calculated sheet carrier concentration as a function of Al mole fraction in the quantum well formed at the GaN/AlGaN heterointerface is calculated and compared to experimental data. Close agreement between experiment and theory is observed. The calculated sheet carrier concentration reflect the maximum carrier concentration possible in the GaN QW for a given Al mole fraction and can not possibly be used to argue in favor of either interface charge or piezoelectric effect as giving rise to the carriers. Based on experimental data the charge density in the AlGaN layer is estimated to be $4 \times 10^{12} \, cm^{-2}$.

The temperature dependence of the quantum well properties formed in $Al_{0.25}Ga_{0.75}N / GaN / Al_{0.25}Ga_{0.75}$ and $Al_{0.25}Ga_{0.75}N / GaN$ are presented. The 2DEG concentration increases with temperature, however, the rate of increase slows down with increasing gate bias implying gain compression with increasing temperature. Calculations show that gain compression is less in $Al_{0.25}Ga_{0.75}N / GaN / Al_{0.25}Ga_{0.75}$ structures than in $Al_{0.25}Ga_{0.75}N / GaN$ based FETs. The presence of the second barrier in $Al_{0.25}Ga_{0.75}N / GaN / Al_{0.25}Ga_{0.75}$ structures gives rise to a well confined two dimensional electron gas as compared to the single barrier structures where the average distance of the electron cloud can be as high as 300Å at 500K under a low gate bias. The behavior of the average distance of the electron cloud indicates that the unity gain cut-off frequency is temperature dependent in single barrier structures, specially at low gate bias. Double barrier structures, on the other hand, may provide with device where the unity gain cut-off frequency is independent of temperature.

The calculations are based upon a simple technique to determine valence band alignments. Calculated values are compared to experimental data showing excellent agreement. A calculated valence band discontinuity of 0.42eV for AlN/GaN is well within the experimental bounds.

INVESTIGATION OF SAMPLING INTERFACES FOR PORTABLE MASS SPECTROMETRY AND A SURVEY OF FIELD PORTABLE ANALYTICAL EQUIPMENT

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Abstract

The major challenge in ascertaining the hazards to humans and the environment when dealing with contaminated sites is determining the types of chemicals present. This is true whether they have been disposed of improperly or are a result of a leaking storage facility. This work has seen great improvements in recent years with the advent of field portable analytical equipment. The technology which has been developed in recent years enabling the use of complex analytical instrumentation in the field has revolutionized the site assessment and site characterization processes. But each of the field portable analytical instruments has its limitations and careful consideration of each instrument's capabilities is critical to the process of gathering useful information regarding the contaminants present at a site leading to judicious remediation decisions. This project consisted of several facets from finding and evaluating field portable instrumentation (Part I) to designing and testing interfaces for sample introduction into mass spectrometers (Part II).

MODELING OF MATERIALS MANUFACTURING PROCESSES BY NONLINEAR CONTINUUM REGRESSION

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Abstract

Since processes for the manufacturing of microelectronic materials are not very well understood, their modeling has to rely on methods that extract models from measured data. A wide variety of these empirical modeling methods is available such as various neural and statistical methods. This report describes the application of a new empirical modeling method called nonlinear continuum regression (NLCR) to various problems relevant to materials science and manufacturing. NLCR is a method that unifies neural and statistical modeling methods that combine inputs by linear projection before transformation by the activation function. These methods include ordinary least squares regression, principal component regression, partial least squares, backpropagation networks, projection pursuit regression, nonlinear principal component regression, and nonlinear partial least squares. Since these methods lie on a continuum the NLCR methodology automatically specializes to the method on this continuum that provides the smallest error of approximation. The NLCR method is applied to data generated by a cellular automata-based molecular model of molecular beam epitaxy. The objective of this case study is to determine if NLCR can provide accurate and compact models for large-scale on-line simulation. The second case study is that of modeling the relationship between the structure and properties of various materials. These case studies demonstrate the ability of NLCR to provide accurate and compact models, and encourage further research.

NONLINEAR TRACKING CONTROL
FOR A PRECISION DEPLOYABLE STRUCTURE
USING A PARTITIONED FILTER APPROACH

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Abstract

As part of the Integrated Ground Demonstration Laboratory (IGDL) mission, the feasibility of a large, deployable, sparse aperture, space telescope is being studied under the UltraLITE project. Precision tracking of the deployable structure via a speaker voice-coil actuated white-light interferometer is the subject of this report.

We have established a new tracking control approach using a partitioned Kalman filter based on measurements of the actuator current and the normalized fringe intensity from an avalanche photo diode. This control has the potential to maintain the optical path difference of the interferometer within desired nanometer tolerances. The theory to support this tracking controller is developed in this report.

ANALYSIS FOR THE ANAEROBIC METABOLITES OF TOULENE AT FIRE TRAINING AREA 23 TYNDALL AIR FORCE BASE, FLORIDA

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Abstract

Benzyl succinic acid, an anaerobic metabolite of toluene under nitrate and sulfate reducing conditions and believed to be a dead-end byproduct, was investigated as a potential indicator of natural attenuation for fuel contaminated sites. Screening for this metabolite at the decommissioned, fire-training area (FTA-23) at Tyndall Air Force Base, Panama City, Florida, did not reveal the presence of any benzyl succinic acid in the groundwater samples drawn from the existing monitoring wells. Similar metabolites, alkyl-substituted benzyl succinic acids that have been identified as products of meta- and para- xylenes and ethyl benzene were also not detected. Detection limits of the separation and analytical method used for benzyl succinic acid were determined for the groundwater from selected monitoring wells. The monitoring wells chosen for study had significantly different contaminant concentrations. The detection limit for groundwater samples that were relatively clean, was found to be near 100 nanograms benzyl succinic acid per liter, for the ether extraction, diazomethane derivatization to the methyl ester, and ultimate GC/MS detection that was used. However, the separation and analysis technique was not reliable for groundwater samples from monitoring wells at the site that were heavily contaminated with fuel components. Although ubiquitous at this particular site, no effects on the analysis could be directly attributed to the presence in the groundwater of residual surfactants from the aqueous film forming foam (AFFF) used to put out the fires.

ASSURED SOFTWARE DESIGN: PRIVACY ENHANCED MAIL (PEM) AND X.509 CERTIFICATE SPECIFICATION

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Abstract

In this document we present two related projects: *

- Formal specification and verification of the Privacy Enhanced mail (PEM) control sequence. The sequence is specified in the language PROMELA based on Hoare's process algebra CSP, and verified using AT&T's model checker SPIN. The contribution of our work is to show that software can be constructed by formal design procedures. The control path is written in a process algebra based on the data path described in higher order logic. The control path is verified using a model checker, and the data path is verified using a theorem prover.

- Semi-formal specification of X.509 certificates. This specification will be translated into HOL.

ADAPTIVE ROBUST SPREAD-SPECTRUM RECEIVERS

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Abstract

In military communications, Direct-Sequence Spread-Spectrum (DS-SS) transmissions are primarily considered as a single user communication strategy that exhibits advanced security characteristics in hostile environments. Still, the presence of other concurrent spread-spectrum signals is possible. These are intelligent hostile users that attempt to severely corrupt the signal of interest. They are highly correlated with the user of interest (aiming at perfect correlation) and completely unknown; thus no control can be exercised to, or knowledge can be acquired about, their spreading codes.

To tap on the relative merits of both non-linear and linear signal processing we propose the following DS-SS receiver for signal detection in non-Gaussian noise: A linear Minimum Mean Square Error (MMSE) or Minimum Variance Distortionless Response (MVDR) filter preceded by a vector of *adaptive* chip-based non-linearities. The novel characteristics of our approach are: First, the non-linear receiver front-end adapts itself to the unknown prevailing noise environment providing robust performance for a wide range of underlying noise distributions. Second, the linear tap-weight filter that follows the non-linearly processed chip-samples, results in a receiver that proves to be effective in combating the SS interference as well. In addition, an approximately optimum DS-SS receiver is derived which accounts for the dependence observed in the received samples due to the common interfering bits.

CONTRIBUTION OF A SCENE PROJECTOR'S NON-UNIFORMITY TO A TEST ARTICLE'S OUTPUT IMAGE NON-UNIFORMITY

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ABSTRACT

A mathematical model of the contribution of the non-uniformity of a projector array to the non-uniformity of a test article's output image was developed. Using this model the maximum theoretical limit for the output image non-uniformity was determined. The realistic situations likely to be encountered during simulation testing were all found to be significantly below the theoretical maximum. The output image non-uniformity is dependent upon the non-uniformity of the projector array, as well as a weighting factor which results from the contribution of the different emitters upon individual detector elements. It is through this weighting factor that parameters such as the sampling ratio, the fill factor of the detector array, the optical blur of the emitters, and the alignment of the emitters with respect to the detectors influence the non-uniformity. A computer program has been written to numerically approximate the weighting factor for a user defined set of parameters.

THE FINITE ELEMENT METHOD IN ELECTROMAGNETICS FOR MULTIDISCIPLINARY DESIGN OPTIMIZATION

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Abstract

Several methods in computational electromagnetics were surveyed to determine the best approach for radar signature prediction/reduction calculations as part of a multidisciplinary design optimization (MDO) program. The finite-element method was chosen as the most suitable approach because of its versatility in simulating complex geometries and because of its similarity and interfacing with structural analysis finite-element grid generation routines. A specific finite-element electromagnetics code was then chosen, studied and tested on canonical and realistic problems. A brief description of the finite-element method for electromagnetics is given, including a description of the code and the computations. A simple example of Radar Cross Section reduction using a finite element code was also provided as a demonstration.

MULTIPLE APERTURE AVERAGING TECHNIQUE FOR MEASUREMENT FULL APERTURE TILT WITH A LASER GUIDE STAR AND EXPERIMENTAL STUDY OF TILT ANGULAR ANISOPLANATISM

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Abstract

A method for measuring full aperture tilt with a LGS is developed. The method exploits a single monochromatic LGS formed through the main telescope and uses two arrays of small auxiliary telescopes separated in orthogonal directions to view the LGS. To reduce the contribution of a down propagation path to the measured tilt, four averaging techniques are used. It is shown that the contribution of the down propagation path can be reduced by averaging a LGS image over FOV of the receiver, over the position of the auxiliary telescope in the telescope array, over position of a subaperture within the auxiliary telescope, and over time. We found that the use of the above averaging techniques permits us to achieve the Strehl ratio equal to 0.7 for various seeing conditions, different telescope diameter, and wavelength, including a visible waveband. A designing methodology for the tilt measurement scheme with a LGS is discussed. An experimental study of the tilt angular correlation scale and the tilt angular averaging function is performed. A new approach of measuring tilt angular anisoplanatism is exploited. This approach employs measurements of the random motion of the portions of a moon edge image to assess wavefront tilt. This technique provides a wide, continuous range of angular separations which are not available in observations with a binary stars. This allows measurements of the tilt averaging function. Besides, the moon is sufficiently bright to enable observations with a high resolution CCD imaging system, and, at any given site and time, the moon is more likely to be available for observations than specific binary stars. In this experiment, the statistical properties of tilt angular correlation and the tilt averaging function were studied. According to estimates based on the tilt averaging function, the tilt angular correlation scale increases by increasing the telescope diameter from 40 *arcsec* to 118 *arcsec*. This indicates that the concept of isoplanatic angle is not applicable to tilt-related phenomena. The data obtained can be used for designing the tilt measurement scheme.

A NOVEL COMPATIBILITY/ EQUILIBRIUM BASED ITERATIVE POST-PROCESSING APPROACH FOR AXISYMMETRIC BRITTLE MATRIX COMPOSITES

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Abstract

A semi-analytical iterative approach for enhancing the existing two-dimensional quasi-continuous axisymmetric stress field for a brittle matrix micro-composite (i. e., a single fiber surrounded by a concentric matrix cylinder), is presented. The existing solution employs Reissner's variational theorem in conjunction with an equilibrium stress field in which the radial (r-) dependence is assumed *a priori*.

In the present approach, the stress distribution in the radial direction obtained from the afore-cited variational model is improved *a posteriori* through an iterative approach that involves successive substitution of the previously computed strains (or stresses) into the equations of compatibility and equilibrium. The equations of compatibility are selected such that they form Euler equations corresponding to appropriate variational principle, such as the principle of minimum complementary potential energy, etc. The boundary/interface conditions at r = constant and z = constant surfaces/interfaces are satisfied in the pointwise sense. The expressions for the improved axisymmetric displacement and stress fields are derived using the symbolic language, MAPLE. An illustrative thermal stress problem is currently being solved, and will be used to compare with the existing variational solution.

DEVELOPING A RELATIONAL DATABASE FOR NATURAL ATTENUATION FIELD DATA

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Abstract

A relational database has been developed to aid interpretation of the results obtained from the test release of a model weathered jet fuel. In an ongoing natural attenuation study conducted at Columbus AFB, a hydrocarbon mixture was emplaced in a well characterized and highly instrumented heterogeneous aquifer. Data is collected at the site through an existing network of more than 300 multilevel sampling wells. This provides a sampling network of more than 6000 sampling points. Water samples at each sampling point can be analyzed for pH, temperature, dissolved hydrocarbons; bromide; electron acceptors including dissolved oxygen, nitrate, nitrite, sulfate, carbon dioxide, dissolved hydrogen, methane, ferrous iron; and stable carbon isotopes. Data from the field and laboratory measurements are placed into several databases. The data are then subsequently analyzed in order to gain insight into the evolution of the geochemical and biochemical processes that contribute to the natural attenuation of hydrocarbons. This research endeavor resulted in the development of a Microsoft ACCESS7 database that will access the various databases, thereby permitting efficient interpretation of the experimental results.

Assessment of the Reliability of Ground-Based Observers for the

Detection of Aircraft

Abstract

In situations in which ground-based lasers are propagated through the atmosphere, either for entertainment or scientific pursuits, there is the chance that aircrew may be exposed to the beam. In most cases this exposure would not be eye-hazardous, but the effects of flashblindness and veiling glare can nonetheless impair mission performance, with potentially catastrophic consequences. In most situations where such lasers are employed, ground-based observers attempt to identify aircraft that are in or near the beam path; occasionally these observers are aided by FAA radar feeds that can assist them in locating these aircraft. In this study we attempt to determine the effectiveness of observers in the detection of aircraft under a variety of conditions, including day versus night, and with and without the assistance of a radar feed. Data collected at Sandia National Labs in Albuquerque, NM, suggest several points. First, detection range is very much greater at night than in the day, probably due to the high contrast between the aircraft and night sky from aircraft lighting, and the increased visual sensitivity of the observers in scotopic viewing. Second, the assistance of a radar feed for daytime observation is important in aircraft detection, not so much to increase the range at which the aircraft is visually acquired, but to increase the likelihood that the aircraft will be detected at all. Overall, the data indicate that the use of a radar feed increases the reliability of the observers, and hence reduces the chances that aircrew will suffer laser eye exposure.

Abstract

In modern aero-engines, a turbine disk is normally cooled by compressed air. A literature survey regarding the turbine disk cooling reveals that although the average air-cooling heat transfer coefficient is generally high, the local heat-transfer coefficient at the disk rim is low. Jet cooling could be used to enhance the heat transfer at the rim, but its implementation is costly. It is believed that one of the major causes of the high temperature at the rim is the low thermal conductivity associated with the turbine disk material. Based on this understanding, a turbine disk that incorporates radially rotating heat pipes is introduced. The incorporation of the heat pipe would significantly increase the effective thermal conductance of the disk and spread the heat from the disk rim to a much large surface area. A unique disk design that employs interconnected heat pipe branches is also proposed for the purpose of cost reduction. To evaluate the effectiveness of the new turbine disk, a simplified analysis based on the one-dimensional and steady-state assumptions is made. The analytical results indicate that the disk that incorporates the heat pipe could reduce the disk rim temperature by more than 300 °C, with only a moderate increase in the disk base temperature. In conclusion, a turbine disk that employs rotating heat pipes is very effective for the disk rim temperature reduction, and it could find important applications in high-pressure gas turbines, such as those being developed under the Air Force program of the Integrated High Performance Turbine Engine Technology.

MDL Texture Segmentation of Compressed Images

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Abstract

The design of efficient, real-time solutions for the problem of segmenting images into "homogeneous" regions is critical for the success of computer vision applications such as automatic target recognition, medical imaging and industrial automation. When images present texture regions, image segmentation becomes one of the most challenging problems in computer vision. In this research we developed a texture segmentation technique based on the minimum description length principle applied to multiband images, that works *directly on semi-compressed data* obtained using a wavelet decomposition. The proposed algorithm saves time and space by operating on compressed data. Furthermore, since it is based on the MDL principle, it does not require ad hoc parameters and it is efficiently implemented using an incremental approach.

VISUAL TARGET TRACKING AND EXTRACTION FROM A SEQUENCE OF IMAGES

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Abstract

This paper presents a methodology for visually tracking and extracting targets from a sequence of images (video). The methodology presented here consists of a combination of algorithms, such as heuristic segmentation, edge detection, thinning, region growing, fractals, feature extraction, graph with attributes, etc., appropriately selected according to the existing situation, such as moving target - still camera, still camera - moving target, moving target - moving camera. The new contribution of this paper is the combination of algorithms in a human like feedback geometric approach of processing low resolution information from consecutive images. Simulated results of the methodology are presented.

Keywords: Visual Target tracking, Feature Extraction, Fractals, Graphs, Processing sequences of images

A REAL-TIME PC-Based Speech Synthesizing Using Sinusoidal Transform Coding (STC)

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Abstract

In this research we investigate a real time speech synthesizing system using a PC platform. Synthesizing was carried out by using Sinusoidal Transform Coding (STC) technique. The proposed synthesizing system works on multi-speakers; the active speakers have their speech signal compressed to 4.8Kb/s while the inactive speakers have their speech signal compressed to 2.4 Kb/s. The code describing the operation of the system is written with C++ and is optimized to allow for a real-time operation.

LOWERING THE COMPUTATIONAL COMPLEXITY OF STAP RADAR SYSTEMS

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Abstract

Space-time adaptive processing (STAP) refers to a class of methods for detecting targets using an array of sensors. The output of the array is weighted using data collected from the sensors over a given period of time. An optimal weight calculation method exists: however, this method is usually computationally impractical. Therefore, various suboptimal methods have been proposed to lower the computational burden of the optimal method. This paper describes one of such methods. The method attempts to exploit the structure and the low rank characteristics of the sample covariance matrix.

A REVIEW OF BENCHMARK FLOWS FOR LARGE EDDY SIMULATION

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Abstract

The purpose of this report is to provide an overview of the standard references on large eddy simulation (LES) of turbulent flows and to outline a series of benchmark flows which can be used to test and validate a new LES code. A list of review articles on LES is given, including several recent papers which show the current state-of-the-art. References for the standard subgrid-scale (SGS) models are provided. An outline is given of flows which can be used as test cases, and references are listed for previous direct and large eddy simulations of these flows, so that comparisons can be made. The emphasis here is on compressible flows; however, many of the test cases included are incompressible. Lastly, several open issues in LES are discussed and some relevant papers are cited.

THEORETICAL FOUNDATIONS FOR DETECTION OF POST-PROCESSING CRACKS IN CERAMIC MATRIX COMPOSITES BASED ON SURFACE TEMPERATURE

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Abstract

Ceramic matrix composites are processed at high temperatures and experience

significant residual thermal stresses upon cooling to the room temperature. These stresses

often result in cracking of the matrix, even prior to the application of external loads. It is

important to detect these post-processing matrix cracks using a nondestructive technique.

The method proposed in this report is based on measurements of the surface temperature

of a ceramic matrix material subjected to cyclic stresses. The elevated surface temperature

is due to friction between the fibers and the matrix that occurs in the presence of bridging

matrix cracks. The solution presents a relationship between the surface temperature and

the matrix spacing that can identify an extend of the damage.

RASTER-TO-VECTOR CONVERSION
OF CIRCUIT DIAGRAMS:
SOFTWARE REQUIREMENTS

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Abstract

This paper presents the requirements needed for Raster-to-Vector Conversion software to effectively convert schematics from scanned raster to vector format. Primary attention is placed on the need for a software package to understand the particulars of the typical format of circuit diagrams. The needs analysis suggests that with such a dedicated software package the entire process could approach the desired goal of fully automated document conversion.

THE NET EFFECT OF A COVARIATE IN ANALYSIS OF COVARIANCE

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and

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Abstract

When we compare two groups or a treatment with a control, the effect of a covariate on the response variable may play an important role. When a covariate is not a demographic variable, it may have to be measured and the measurements may be expensive or complicated. In such cases, it may be wise to assess the importance or effectiveness of it with respect to the response variable. In this paper, we develop some inferential measures that can be used to assess the net effect of the covariate on the response variable. The procedures developed can be used for both fixed and random covariates. We also develop an index similar to the percent reduction index to assess the percent decrease (or increase) in the mean difference due to the covariate. We provide confidence intervals for this index.

PARALLEL PROCESSING FOR TUBINE ENGINE MODELING
AND TEST DATA VALIDATION

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Abstract

The Arnold Engineering Development Center (AEDC) uses a variety of turbine engine simulation and test data analysis programs to enhance its testing capabilities. Traditionally, these programs have been executed off-line, sometimes at processing speeds that are several orders of magnitude slower than the speed at which the test data is acquired. Increasing demand for faster test turnaround times and data accuracy necessitates the integration of on-line simulation and data verification into the testing process. This paper describes two efforts towards this goal: a study to speed up a Computational Fluid Dynamics (CFD) solver code which is used in a three dimensional turbine engine compressor model, and a parallel signal feature extraction system.

A Study of Intra-Class Variability in ATR Systems

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Abstract

In this report we describe the results of our investigation into the intra-class variability of a vehicle class from the perspective of an automatic target recognition system. We examine the relevance of synthesized vehicle models for ATR systems and conclude that these models fall within the bounds of the vehicle class set by the intra-class variability of the vehicle. We also demonstrate the relevance of the mean-square-error between an image chip and a template when used as a measure of distance between the physical vehicles. We also show that it is feasible to intelligently merge chips from different vehicles of a class and construct classifiers that perform better than those designed with any individual member of the vehicle class.

SPINNING HOLLOW FIBERS FROM HIGH PERFORMANCE POLYMERS

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Abstract

Hollow fibers spun from synthetic polymers have been investigated for a long time, especially for producing high-bulk, low density fabrics. Advantages of hollow fibers over solid round fibers are improved thermal and acoustical properties, reduced pilling, special optical effects and greater dielectric strength. Also, hollow fibers exhibit less fibrillation tendency under flexing conditions. Such fibers produced from a high temperature resistant polymer have advantages in some of the intended applications. A special set-up was built at the Phillips Laboratory of Edwards AFB, CA to spin hollow fibers. Using that set-up, hollow fibers were spun from two grades of Ultem. The same set-up was used to obtain thick coating of Ultem on copper wires. Influence of varying some of the processing conditions on the fiber structure was analyzed. Feasibility of solution processing of Ultem was also investigated.

SYNTHESIS OF NOVEL ORGANIC COMPOUNDS AND POLYMERS FOR TWO PHOTON ABSORPTION, NLO, AND PHOTOREFRACTIVE PHOTONICS APPLICATIONS, AND VISIBLE DYE-SENSITIZED PHOTOPOLYMERIZATION

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Abstract

The synthesis of novel low molar mass organic chromophores, bearing arylamine electron-donating and phosphonate, nitro, or benzothiazole electron-withdrawing functionalities was undertaken. Two new fluorene-derived molecules were synthesized via amination and Heck coupling reactions. 2-(4-Iodophenyl)benzothiazole, the penultimate precursor for 2-(4-vinylphenyl)benzothiazole, was prepared. Regiospecific bromination methodology was investigated to prepare specifically brominated aromatic amines, including N-4-bromophenyl N,N-diphenylamine, bis(4-bromophenyl)amine, poly(3-bromo-9-vinylcarbazole), and poly(3,6-dibromo-9-vinylcarbazole). Attempted dibromination of triphenylamine, however, lead to a mixture of mono-, di-, and tribrominated products. Regiospecific O-allylation of N-(3-hydroxyphenyl)-N-phenylamine was attempted under two sets of reaction conditions, affording, in each case, a mixture of predominately O-allylation accompanied by a lesser amount of N-allylation. Heck coupling of diethyl 4-vinylbenzene phosphonate and N-4-bromophenyl N,N-diphenylamine was conducted to form 4'-N,N-diphenylamino-4-diethylphosphonostilbene. In a similar manner, Heck reaction of poly(3-bromo-9-vinylcarbazole) and 4-nitrostyrene was carried out to produce poly(3-(4'-nitrostilbene)carbazole).

Preliminary visible dye photoinitiated polymerizations were conducted to assess the possibility of developing a polymerization initiator system that can utilize infrared two-photon pumped up-conversion fluorescene as a means to generate spatially resolved visible photons. Photopolymerization of an acrylate/epoxy functionalized monomer was accomplished with a commercial dye/coinitiator system and one based on one of the aforementioned new fluorene-derived compounds.

RECONSTRUCTING THE INFORMATION WARFARE ATTACK SCENARIO: GUESSING WHAT ACTUALLY HAD HAPPENED BASED ON AVAILABLE EVIDENCE

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Abstract

A crucial component in the information warfare is to be able to identity the culprit and to take appropriate

actions against the culprit such as to prosecute the culprit in courtroom or launch a counter attack. In

order to do so, it will be extremely useful to be able to "reconstructing the information warfare attack

scene". In this paper, a specific approach in reconstructing the information warfare attack scenario is

proposed. Future research directions in theory and computerized tools are discussed.

INVESTIGATION OF TWO STATISTICAL ISSUES
IN BUILDING A CLASSIFICATION SYSTEM

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Abstract

This research investigates two statistical issues of relevance to current approaches in building a personnel classification system within the Air Force. The first issue is the effect of the non-random selection of the accessions sample on the least square estimates of the regression models used in predicting job performance. The second issue is the effect of the reliability (unreliability) of the predictors (ASVAB subtest scores) on the regression weights estimates. Several carefully designed simulation experiments were performed. The results show: (1) estimation based on the nonrandomly selected samples does not produce systematically biased regression weights estimates (although the estimates have inflated standard deviations primarily due to reduced sample size); (2) estimation based on not perfectly reliable predictors produces biased estimates of the regression weights. Certain "remedy" procedures were proposed and were evaluated by simulation studies as well.

BLACKHOLE ANALYSIS

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Abstract

Blackhole space is a parallel universe to the complex plane in which some problems can be worked more easily and others with greater difficulty. The theorems of blackhole space are presented here and their application to superposition in signal processing. Parallel programs exist to any existing program, even some parallel machines.

Detection techniques use in forward-looking radar signal processing system:
A Literature Review

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Abstract

(FLAR) Forward-looking airborne radar system, as oppose to (SLAR) side looking airborne radar, allows high target to background contrast, accurate azimuth estimates, day and night operation, and can, to a limited degree, penetrate fog, haze, and dust. On the down side, forward-looking IR radar has range uncertainty, generate false alarm from background clutter, has difficult with occlusion of targets by vegetation and terrain, and is aspect angle dependent. The concept of detection and identification of targets, in nonstationary environment and obscure by inteferences such as clutter, jammer, and noise entails suppressing these inteferences with effective signal processing scheme.

In this report, we will present a comprehensive review of the different STAP algorithms and Neural Network methods, without analytical justification of these algorithms and methods. use for detection of target, obscured by interference such as clutter, Jammer, and noise, applicable to forward-looking airborne radar system.

RE-ENGINEER AND RE-MANUFACTURE AIRCRAFT STRUCTURAL COMPONENTS USING LASER SCANNING

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Abstract

In the summer of 1995, a feasibility study was initiated to study the applicability of laser scanning to aircraft structural component manufacturing. A sample part, F-15's leading edge rib, was selected and scanned at Laser Design Inc. (LDI) and Shamoa Corp, respectively.. Following scanning, a CAD model was created at LDI and an aluminum part was machined at Shamoa. The results from this study indicated that laser scanning had matured to a stage that they could possibly capture and reproduce intricate surface details typically present in aircraft structural components. However, the data produced did not show enough accuracy for the Warner Robins Air Logistics Center (WR-ALC) to implement this new technology on their production floor.

A follow-up study was conducted at WR-ALC in the summer of 1996. To broaden the scope of the study, two more sample parts, an F-15's canopy fitting and a C-141's forward latch fitting, were also included. A research plan that could demonstrate the accuracy and efficiency of laser scanning in duplicating existing aircraft structural components was devised. Because of time constraints, only a few tasks in the research plan were completed in the 1996 summer. The principal investigator, committed to complete this research work, has been using the manufacturing facilities at his university to continue this project since the completion of the 1996 summer program.

During the summer of 1997, entire effort was again devoted to the laser scanning project. In this report, the work performed during the 1997 summer research program and the plan to complete the entire project by the end of this year are presented.

USE OF AIR SYNTHETIC FORCES FOR GCI TRAINING EXERCISES

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Abstract

Air Synthetic Forces (AirSF) provide a model or air combat pilot decisions, actions, and communication that can be fed to ModSAF, which then simulates aircraft performance in a Distributed Interactive Simulation (DIS) of combat operations. In training Modular Control Equipment (MCE) operators in the performance of Ground Controlled Intercept (GCI) procedures, it would be useful to have synthetic target images that behaved like "real" pilots. AirSF has the potential for providing a computer-based surrogate for pseudo-pilots currently used in large-scale training exercises or MCE simulations.

Pseudo pilots typically are airmen who try to emulate pilot actions using the built-in MCE simulation capabilities. They often are not well-versed in MCE console operations and do not know what pilots do about air combat operations. So these pseudo pilots are not always good surrogates for actual pilots, and it was hoped that AirSF models might actually out-perform the pseudo pilots in training exercises.

The present study examined what MCE operators are expected to do and reviewed the available AirSF documentation to determine what the software could do (and how well it acted like real pilots might). However, those questions cannot be answered from the documents reviewed. Empirical testing of AirSF will be needed in order to answer the question: Can AirSF do better than (and therefore replace) pseudo pilots in training MCE operators in GCI operations?

SUITABILITY OF ASCIDIANS AS TRACE METAL BIOSENSORS-BIOMONITORS IN MARINE ENVIRONMENTS: AN ASSESSMENT

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Abstract

Ascidian tunicates are filter-feeding benthic invertebrates known to concentrate a wide variety of trace metals of no known biological function in their blood and tissues. An investigation was initiated to determine whether wild populations of these organisms could reliably be used to monitor trace metal enrichment in marine ecosystems. Research was conducted in St. Andrew Sound, a shallow marine lagoon bounded by Tyndall Air Force Base, Florida. The present report summarizes habitat preferences, seasonal distributions and the relative abundance of dominant ascidian taxa in the lagoon. Many of the 21 species collected have some potential use as trace metal biomonitors. However, only *Styela plicata* and *Molgula occidentalis* are present in abundance year-round, occupy all major habitats, and are easily maintained in laboratory conditions. Significant intra- and inter-colony phenotypic variation in *Didemnum, Diplosoma,* and *Distaplia* species resulted in equivocal identification at the species level, and the geographic and/or seasonal distributions of *Trididemnum, Clavelina, Eudistoma, Aplidium, Ecteinascidia* and *Botryllus* species were limited, or restricted to uncommon habitats in the lagoon. Taxonomic uncertainties and low survivability of didemnid and polycitorid colonies in laboratory conditions suggest that use of these taxa in metals accumulation/toxicity bioassays, or in environmental assessments, is impractical.

DESIGN OF A MASS SPECTROMETER SAMPLING PROBE FOR AEDC IMPULSE FACILITY

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Abstract

The work reported was part of the NUNN/DLR FPST Project, which is an International Cooperative Research and Development Project between Arnold Engineering Development Center (AEDC) and the German Research Center for Aviation and Space Travel (DLR), to obtain hypersonic data for code validation in Free Piston Shock Tunnel (FPST) facilities. Of major concern is the measurement of the chemically pure run time of the facility. A time-of-flight mass spectrometer (TOFMS) probe sampling system which will be used to make this measurement is described. Computational fluid dynamics (CFD) computations were performed to design a system of three coaxial skimmers cones that will extract a gas sample in the form of a molecular beam and transmit the beam to the TOFMS. Interpretation of the mass spectra and integration of the TOFMS with the FPST are discussed, including the sizing of the various probe chambers and the associated vacuum pumps.

SCHEDULING in the

DYNAMIC SYSTEM SIMULATION TESTBED

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Abstract

The task of a sensor manager is to improve the performance of the individual avionics sensors by coordinating their activities based on the sensor manager's best estimate of the future. The Dynamic System Simulation Testbed (DSST) was developed by Data Fusion Corporation to test different sensor manager concepts. This report covers the use of the DSST to evaluate several genetic search schedulers. The goal is to find schedulers that can improve the performance of the baseline greedy scheduler in the DSST. Several performance measures are used to assess the performance of the schedulers. Results show that for the scenario considered here it is difficult to improve on the performance of the greedy scheduler. While the genetic scheduler improves some measures the improvement is not dramatic. The evaluation function used to drive the genetic search tries to execute higher priority jobs earlier in the scheduling window. While the evaluation function was effective at scheduling higher priority jobs in the scheduling window, it did not seem to schedule them earlier in the cycle. Rather the tasks seemed to be more randomly distributed over the planning cycle. It is suggested that a different scenario and a modified evaluation function might show more differences in the performance of the greedy and genetic based schedulers.

RAT ULTRASOUND VOCALIZATION DEVELOPMENT AND NEUROCHEMISTRY IN STRESS-SENSITIVE BRAIN REGIONS

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Abstract

Three experiments tested the hypothesis that an individual rat's propensity to emit ultrasounds is related to other biobehavioral measures of stress. In the first experiment, the number of isolation-induced ultrasounds emitted by male rat pups 10 days old was positively correlated with hippocampal concentrations of the serotonergic metabolite 5-hydroxyindole acetic acid, and negatively correlated with frontal cortex concentrations of the dopaminergic metabolite 3,4-dihydroxyphenyl acetic acid. In the second experiment, vocalizations of female rats were longer when their odor preferences were tested in a situation where only unfamiliar odors were present, than in a situation where familiar nests odors were present. In the third experiment, two weeks of restraint stress immediately after weaning reduced body weight gain and thymus weight in male and female rats, and also reduced thymus to body weight ratios in females. However, restraint did not induce significant differences between control and restraint groups in vocalization parameters. Whether these parameters correlate with brain monoamine measures will be determined when assays now in progress are completed. The results to date support the hypothesis that ultrasonic vocalizations by rat pups are related to other biobehavioral indicators of stress.

Feature Based Cost Modeling

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Abstract

Feature based cost modeling is a parametric cost approach using product features that are available to the designer including shape features such as volume, external surface area, internal surface area, and projected area; production features such as production quantity; and material features such as density, strength, and modulus. A literature review revealed little data on manufacturing costs of parts, and most of the USA data referred to a study by Boeing in the 1950's. The feature that has been primarily utilized in the past has been part volume, but projected area and dimensional ratios have also been utilized. A form was developed to collect manufacturing cost data to develop cost expressions to be utilized by designers. Future work plans are to collect and analyze data to develop feature based cost expressions considering new feature variables.

A THREE-DIMENSIONAL, DIELECTRIC ANTENNA ARRAY RE-CONFIGURABLE BY OPTICAL WAVELENGTH MULTIPLEXING

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ABSTRACT

Semiconductor antennae activated by fast laser pulses can serve as effective sources of broad-bandwidth electromagnetic radiation. The electromagnetic radiation is generated by accelerating optically stimulated carriers with a high voltage electric field within or along the surface of the semiconductor. If the photo-carrier lifetime is much longer than the laser temporal pulse width, the electromagnetic radiation waveform essentially emulates the optical pulse profile. We report here a three dimensional (3-D), reconfigurable, semiconductor based, phased array antenna which is activated by multiple wavelength, picosecond laser pulses (optical wavelength multiplexing). Based upon the nonlinear characteristics of the radiated field as well as dielectric nature of the semiconductor antenna elements, a 3-*dimensional* array can be implemented with minimum cross-talk among the elements. The antenna is reconfigurable by varying combinations of the applied voltages, optical beam geometry, and laser wavelengths. As suggested by theory, we have demonstrated experimentally that the radiation pattern of such an antenna is sensitive to the 3-D geometry of the radiation source. This, in turn, can be varied in a continuous manner by optical wavelength multiplexing.

OBJECTS AND METHODS FOR AIRCRAFT CONCEPTUAL DESIGN AND OPTIMIZATION IN A KNOWLEDGE-BASED ENVIRONMENT

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Abstract

This report discusses the development of object models and methods in the "Adaptive Modeling Language" (AML) environment to assist in the conceptual design of aircraft. Two related research efforts were made. The first emphasized the development of aircraft design objects that include properties and geometry necessary for aircraft conceptual design. The second focused on the creation of optimization methods for use in the AML environment. Several advantageous features of AML were exploited in both of these efforts. Recommendations resulting from this work offer promising advances for faster, more accurate aircraft conceptual design leading towards improved affordability of aircraft.

VIBRATIONAL ANALYSIS OF SOME HIGH-ENERGY COMPOUNDS

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Abstract

Infrared spectra were obtained and vibrational (normal coordinate) calculations were made for 1,3,3-trinitroazetidine (TNAZ), 1-acetyl-3,3-dinitroazetidine (ADNAZ), and 1-nitroso-3,3-dinitroazetidine (NO-DNAZ) in an effort to learn more about the conformational behavior of these compounds and to make assignments of the observed infrared bands to the appropriate normal modes of vibration. Molecular mechanics and semi-empirical molecular orbital calculations (MNDO-AM1) were also made in order to obtain additional information about the molecular structures. Normal coordinate calculations were made first for the slightly less complex molecule 1,3-dinitro-3-bromoazetidine in order to obtain force constants to transfer to ADNAZ. Appropriate force constants obtained for ADNAZ were then used as starting values for TNAZ. The resulting force constants obtained for TNAZ were transferred successfully to NO-DNAZ. It was shown that the observed frequency shift of the C=O stretch band of ADNAZ and the (N)-NO_2 antisymmetric stretch and (N)-NO_2 out-of-plane wag bands of TNAZ can be explained by a change in the conformation that is initially present to another conformation during recrystallization after mixtures are melted. The normal coordinate calculations produced vibrational potential energy functions that resulted in calculated vibrational frequencies that were in excellent agreement with the observed frequencies for all four compounds.

Geometrically Invariant Nonlinear Recursive Filters, with Application to Target Tracking

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ABSTRACT

The Geometrically Invariant Nonlinear Recursive Filter, or GI Filter, is a coordinate-independent geometric generalization of the Kalman Filter for a continuous-time nonlinear state process subject to discrete-time observations. It is optimal in the sense that, if a linear system were subjected to a nonlinear transformation f of the state-space and analyzed using the GI Filter, the resulting state estimates and conditional variances would be the push-forward under f of the Kalman Filter estimates for the untransformed system – a property which is not shared by any of the variants of the Extended Kalman Filter.

The state process, which can be any Markov diffusion process, induces (through its covariance structure) a Riemannian metric on state space, and the observation covariance induces a Riemannian metric on observation space. Using the associated Levi-Civita connections, and gamma-martingale theory developed in a separate article, we are able to construct intrinsic location parameters (ILP) for the state and the observation, and thereby propagate the system dynamics in a coordinate-free way. An intrinsic generalization of the Kalman filter update formula allows recursive updating of state estimates and covariances.

As an example, the GI Filter is applied to the problem of tracking and intercepting a target, using sensors based on a moving missile, and explicit formulas are given. A software implementation using MATLAB is under development.

AMS (1991) SUBJECT CLASSIFICATION
Primary: 93E11. Secondary: 60H30, 65U05

KEY WORDS
GI filter, nonlinear filter, Kalman filter, stochastic differential equation, forward-backwards SDE, geometrically invariant

A STUDY OF THE EMERGING DIAGNOSTIC TECHNIQUES IN AVIONICS

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Abstract

An in-depth study of the Emerging Diagnostic Techniques and their applicability to avionic and non-avionic systems was undertaken. The transfer function method model developed by Popyack and Skormin (Ref 1) was studied in detail and a Complementary Model using The Finite Element techniques was developed. An experimental set up using The Time Stress Measurement Device (TSMD) Technology was developed to generate experimental data to validate the model results.

INFORMATION FUSION FOR TEXT CLASSIFICATION - AN EXPERIMENTAL COMPARISON

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Abstract

This report is on our recent software development, experiments, and results on automatic classification of free text documents into a given number of categories. Text classification has applications in information filtering and routing, automatic indexing, retrieval, etc. We use different kinds of feature extractors and integrate neural net learning into the method. We then compare their performance and that of different interesting combinations of them using different metrics.

The feature extractors are based on the "latent semantics" of a *reference library*. Intuitively, the technique of latent semantic indexing (LSI) [Deerwester, et al., 90] projects any document into a dimensionally reduced space of concepts from the reference library. Different sets and sizes are used for the reference library to form different features. Terms, noun-phrases, and simple category profile matching are used in the features. Neural nets are used to incorporate a learning component, as well as to fuse information from different combinations. Metrics such as micro and macro averaged precision, recall and correctness are used to compare the performance of the different feature extractors and effectiveness of their fusion.

The results indicate that a larger reference library is not necessarily more effective. However, information fusion almost always performs better than information from the individual feature extractors, and certain combinations seem to do better than the others. Additional parameters can have varying degrees of effectiveness, and remain to be investigated.

QUANTITATIVE DESCRIPTION OF WIRE TEXTURES
IN
CUBIC METALS

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Abstract

The results of x-ray measurements of texture in metallic materials are usually represented graphically employing a method dictated by the measurement technique. Two of the most commonly used representation of texture are the crystallographic pole figure and the inverse pole figure. There exists two types of textures sheet and wire. The rotational symmetry about an axis makes the wire texture simpler to described than a sheet texture. Two x-ray techniques are presented which quantify wire textures. They are the $\Theta/2\Theta$ and the ODF methods. The $\Theta/2\Theta$ method has the advantage of being much quicker than the ODF method, however it is not as robust. This investigation reports the results obtained from employing the $\Theta/2\Theta$ and the ODF methods to quantify the texture in two investigations. The texture changes occurring during annealing of ten specimens of cold worked and annealed copper cut from a eight inch diameter 3/8 inch thick plate were determined in one investigation. The texture evolution in a series of copper compression specimens was monitored in a second investigation. In the two studies both x-ray methods generated almost identical texture descriptions.

EFFECT OF IRON CORROSION INHIBITORS
ON REDUCTIVE DEGRADATION OF CHLORINATED SOLVENTS

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Abstract

A laboratory study has been performed to examine the inhibition effects of 14 organic and inorganic chemicals (including various amino acids, phosphate, sulfate, borate, molybdate, and silicate) on anaerobic iron corrosion and trichloroethylene (TCE) degradation. Anaerobic iron corrosion is characterized by measuring hydrogen production, and TCE degradation was evaluated by the formation of the reduction products, ethylene and ethane. Some compounds such as cysteine dramatically decrease the rate of hydrogen production and also the rate of TCE reduction. Other chemicals such as histidine may not inhibit hydrogen production but still decrease the rate of TCE degradation. Such information may provide valuable insights into the relationship between anaerobic iron corrosion and chlorinated solvent reduction. An improved understanding of corrosion inhibition will help us to improve and refine metallic iron-based remediation technologies.

ANALYSIS AND CONTROL DESIGN FOR A NOVEL RESONANT DC-DC CONVERTER

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Abstract

A novel topology for a resonant DC-DC converter was studied. Theoretical analysis, control design and computer simulations of this converter system were performed. Based on the results of this work, a patent will soon be applied for.

COPULATORY RESPONSE, FERTILIZING POTENTIAL, AND SEX RATIO OF OFFSPRINGS SIRED BY MALE RATS EXPOSED *IN UTERO* TO AN ULTRAWIDEBAND ELECTROMAGNETIC FIELD OR LEAD ACETATE DURING DAYS 3 TO 18 OF GESTATION

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Abstract

To evaluate whether Ultrawideband (UWB) exposures have the potential to affect developmental processes, studies were initiated using a rat model at Brooks AFB. The UWB source used for that study (Cobb et al.,1996) was a microwave transmitter that was capable of generating electromagnetic pulses ranging from near DC to several GHz, but had, as a primary component, microwave pulses in the MHz range. Mated females were obtained from a commercial vendor (Charles River, Inc.). On arrival, post-mating day 3, females were randomly assigned to UWB-exposure, sham-exposure, or a lead-treatment group. Treatments were administered to rats during days 3 to 18 of pregnancy and included the UWB exposures using a parallel-plate transmission line, sham-exposure, or administration of lead acetate (2 mg/ml) via the drinking water provided to the dams as a positive control (Cobb et al.,1996). Females were monitored for pregnancy, birth and survival of offspring, and sex distribution of the pups born. Offsprings born to control and treated groups were evaluated for evidence of neurological impairment using behavioral tests (Cobb et al. 1996). All behavioral testing was completed for these rats by post-partum day 62. From these pups (Cobb et al., 1996), 12 male rats, 2 litter mates from each of 2 litters for each treatment group, were retained for evaluation of reproductive capability at sexual maturity and to evaluate whether prenatal exposure to the prescribed conditions exerted latent reproductive toxicity in the exposed feti. For this purpose, male rats born to females from sham-exposed, UWB-exposed, and lead-treated groups were caged individually and then paired with estrous female rats beginning on post-partum day 132. A total of 98 pairings with estrous females were made and 43/98 (44%) resulted in mating. Data analysis data revealed a trend (P < 0.1) for an effect of treatment on the number of male-female pairings to result in mating, however no effect of treatment was found for the proportion of fertile matings, viability and development of embryos, survival to term, and sex-ratios of offspring born to males that were exposed *in utero* to the UWB field.

GUIDING MISSILES "ON THE FLY:"
APPLICATIONS OF NEUROBIOLOGICAL PRINCIPLES TO MACHINE VISION FOR ARMAMENTS

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ABSTRACT

The goal of this project was to evaluate the potential for applying information processing strategies from the visual systems of flying insects to biomimetic designs for missile guidance technology. A review of various neurobiological publications was supplemented by additional readings on analog VLSI and other biomimetic technology, and by briefings provided by personnel at the Wright Laboratory, Eglin AFB, regarding current technology for guided munitions. Three major information processing paradigms were identified as essential components of the functional organization of visual processing in the fly brain: (1) multiple spatially mapped representations that are connected and processed in parallel, (2) "coarse coding" of input parameters, and (3) matched filters tailored to specific, often complex features of the raw sensory inputs. Together, these paradigms provide a conceptual basis for designing revolutionary new guidance systems, some proposed components of which are described in this report. The numerous advantages of incorporating these biological principles into man-made designs include the elimination of any need to solve complex equations, or even to perform explicit mathematical computations at all. Instead, in the insect brain and the emulations proposed here, all algorithms and computations are encoded implicitly in the overall physical architecture and the functional properties of its components.

THE EFFECT OF VISUAL SIMILARITY AND REFERENCE FRAME ALIGNMENT ON THE RECOGNITION OF MILITARY AIRCRAFT

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ABSTRACT

Aircraft similar in appearance (homogeneous) and dissimilar in appearance (heterogeneous) were studied at orientations consistent with the environmental frame of reference (canonical) or inconsistent with the environmental frame of reference (non-canonical). Response time data for correct identifications indicate that identification performance was better for heterogeneous than homogeneous aircraft. This performance advantage for heterogeneous aircraft was found at both the original training orientations and for novel orientations. Canonical orientations during learning produced better identification performance than non-canonical orientations. Implications for aircraft recognition training are discussed.

IMAGE RECOVERY USING PHASE DIVERSITY

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Abstract

The use of phase diversity to recover aberration-free images was the focal
point of the research carried out under the Summer Faculty Research Program.
Computer simulations were used to demonstrate that phase diversity can be
used to remove aberrations from an image and that the Gonsalves error metric
approach can be successfully implemented toward that goal. An experiment was
designed to utilize a phase diversity camera for imaging aberrated wavefronts.
It is proposed that such an experiment be carried out in order to determine
the effectiveness of the phase diversity technique under "real life"
conditions.

MODELING THE CHARGE REDISTRIBUTION
ASSOCIATED WITH DEFORMATION AND FRACTURE

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ABSTRACT

Attempts to correlate the bonding in crystalline materials with mechanical properties often employ quantum mechanically determined charge density difference maps. The interpretations which result from the use of these maps lack rigor, are ambiguous, and often provide contradictory rationale as to the origins of specific properties. Based on these results, some have suggested that first principle calculations may have little to offer in the development of a more fundamental understanding of the mechanical properties of metals and alloys. Here, we build on the work of Bader and show that the geometric properties of the total charge density at its Morse points provide a concise and unambiguous description of crystalline bonding and the change in this bonding associated with deformation and fracture. The description which results is used to account for the previously unexplained trends in mechanical properties of the B2 aluminides of Fe, Co, and Ni.

ENHANCING THE ROME LAB ADII VIRTUAL ENVIRONMENT SYSTEM

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Abstract

An effort to understand and enhance Rome Laboratory's virtual reality system was undertaken. The Cubeworld software system was modified to enable user-induced changes in the position of the observer and the center of projection—thereby producing changes in the binocular disparity of the stereoscopic image. Further additions to the program permit interactive scaling of the scene. Attempts were made to streamline the dual (stereoscopic) viewing/projection pipelines to enhance the performance of the system. A software "fix" to a damaged VPL Dataglove was implemented, and new voice commands for the HARK speech recognition system were instituted. The latter involved modifications of the grammar file and of the program running on the machine generating the Cubeworld virtual world simulation as well as on that running the speech recognizer. A major accomplishment was the incorporation of primitive three-dimensional sound into the simulation. An animated object was created with Designer's Workbench and added to Cubeworld's list of objects. On each iteration of the simulation's main event loop, the object updates its position on a circular trajectory and reports this position as well as the frequency and amplitude of the virtual sound it is emitting to the program running on the machine that will generate the sound. The communication is done via network sockets. Routines to handle this communication were implemented in the programs running on both machines. The receiver side program uses the information it receives to compute the interaural time difference and interaural intensity difference of the sound that would arrive at each ear of the observer. These have been shown to be the primary cues a human being uses to localize the source of a sound in three-dimensional space. The receiver program also computes the Doppler frequency shift. The results of these computations are used to fill the system's audio buffer, which, in turn is read by the audio hardware. The result is the generation of a sound to each earphone worn by the observer of the simulation. Thus the sound perceived by the observer is similar to that he would have heard if he had really been in the world in which the sound source was moving. This enhances the reality of the simulation.

THEORY OF PROTONS IN BURIED OXIDES

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Abstract

We have developed a model for electron capture at protons in a-SiO$_2$ under U-V illumination. The electrons are excited from the valence band to the gap level of the proton. The previously observed temperature dependence can result from competition between hydrogen motion away from the defect site and radiative recombination that would leave the proton as it was. At low temperature we argue that the latter dominates. At elevated temperatures, the system is vibrationally excited which leads to greater probability of hydrogen motion. This model not only explains previous observations, it predicts new results that can be readily tested experimentally. This model is buttressed by *ab initio* molecular orbital calculations and by a finite element analysis of vibrational spectra. Using the vibrational wave functions, we have completed a vibronic model for electron capture, including calculation of vibrational probability factors. This model is a work in progress. In an accompanying proposal we discuss our plans for completion of this work.

ON THE DEVELOPMENT OF PLANAR DOPPLER VELOCIMETRY

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ABSTRACT

A molecular filtered based laser diagnostic technique termed Planar Doppler Velocimetry (PDV) has been developed to measure the velocity field in a two dimensional image. Using an injection seeded Nd:YAG laser, the beam is expanded into a sheet to illuminate the flow under study. Two cameras are used to record the image. The filtered camera has an iodine cell in front of it which discriminates the intensity with respect to frequency. A second camera, which is not filtered, is used as a reference to eliminate variations due to seeding or laser fluctuations. From these two images the transmission ratio is calculated and used to obtain the velocity of the flow field. The PDV system and programs have been created to make the technique more user friendly and reduce the uncertainties in the measurement as much as possible. Several different flow fields were investigated. A small axisymmetric jet facility was used to test the experimental arrangement, data collection and reduction programs, and investigate sources of error (laser speckle, misalignment, laser frequency fluctuations, split image arrangements, etc.). The uncertainty in the measured velocity was found to be less than 4 m/s. PDV was then incorporated in "large scale" wind tunnel facilities studying supersonic (injection into a supersonic free stream) and subsonic (the interaction of a leading-edge vortex and a vertical tail) flows.

MODELING THE MAGNETOSPHERIC MAGNETIC FIELD

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Abstract

Following the formalism developed by Heinemann and collegues, development of a numerical method for obtaining the three-dimensional, equilibrium, magnetospheric magnetic field has begun. Expressing the distributed currents of the magnetospheric plasma in terms of an effective magnetization $\mathbf{M}_{eff}$, the magnetic scalar potential ψ is found as a solution of Poisson's equation. The magnetic field is $\mathbf{B} = \mu_o \left(-\nabla\psi + \mathbf{M}_{eff} \right)$ in MKS units, just as in an ordinary diamagnetic material. In this first stage of development, numerical solutions have been found in a closed rectangular geometry, with symmetry about the equatorial and noon-midnight meridian planes, and isotropic pressure with an assumed distribution in the equatorial plane.

EVALUATION OF THE POINTWISE k-℘ TURBULENCE MODEL TO PREDICT TRANSITION AND SEPARATION IN A LOW PRESSURE TURBINE

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Abstract

Low pressure turbines in aircraft experience large changes in Reynolds number as the engine operates from take-off to high altitude cruise. Many low-pressure turbine blades contain regions of strong acceleration and diffusion. As the Reynolds number decreases, these regions develop large unsteady transitional and separation zones. Computational models show limited success in predicting such flow phenomena. The point wise k-℘ turbulence model has been recently proposed to represent wall bounded and free shear flows. Thus, it may be conveniently used to represent turbine flows, which are often modeled with a mesh around the airfoil (O-grid) interacting with another mesh, for the outer flow (H-grid). The point wise k-℘ model is used here with a meridonial coordinate system to evaluate its ability to predict transition length, as well as boundary layer separation, on a two-dimensional linear low-pressure turbine blade cascade. The new turbulence model is evaluated with experimental results of a low-pressure turbine blade cascade.

Concurrently, a fundamental study of the flow dynamics around a blade with oscillating cooling flow is being investigated. A transient solution of the Reynolds-averaged Navier-Stokes, continuity, and energy equations is being developed to analyze the effects of a pulsing jet on vortex development and interaction with the blade surface. Current studies suggest that an oscillating bleed flow passed through a turbine rotor blade can reduce the friction drag on the blade. Furthermore, the resulting boundary layer structure and possible separation from the blade will decrease the effective available area for the high-speed flow between adjacent blades, improving off-design performance. The status of this effort is discussed.

VERTICALLY INTERCONNECTED 3D MMICs
WITH
ACTIVE INTERLAYER ELEMENTS

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Abstract

Vertically interconnected 3D monolithic microwave integrated circuit (MMIC) design is extended into a new novel configuration with active layers dispersed between the interlayers. In a conventional 3D MMICs various active devices including transistors, resistors and capacitors are all placed on the base substrate. The upper layers contain the passive elements for necessary matching networks, bias networks and transmission lines connecting various circuit elements. In the modified proposed configuration, high power devices (i.e., HBT developed at WL) are placed on the substrate and additional circuit elements including low power active devices are dispersed between various layers. This is possible with the recent advances made in SOI transistor technology. NMOS transistors can be processed by first deposition of polysilicon on any layer, followed by laser crystallization of the polysilicon islands and followed by transistor processing.

TARGET IDENTIFICATION FROM LIMITED
BACKSCATTERED FIELD DATA

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Abstract

The problem of determining the nature of a target from limited backscatter data contains two difficult features. The first is the problem of inverting scattered field data when multiple scattering arises. There are few proposed theoretical methodologies do this and even fewer computationally feasible algorithms. The second problem lies in the fact that one would normally hope to have scattering data taken all around a target for all possible illumination directions. This is a luxury that rarely exists. We have adopted a simple signal processing-based approach to solving the inverse scattering problem when only limited incident and backscatter angles are available. We have applied these techniques to real data measured at Rome Laboratory using microwaves and model targets whose structure is known *a priori*. Some of these data have been made available to the imaging community at large but without revealing the structure of the target. This has proved to be a very important exercise when it comes to comparing different inversion techniques and their claimed success. During this summer internship, recently provided data were processed using an inversion method we refer to as cepstral filtering. All of the so-called mystery targets were imaged although their resolution was poor. These results were presented at a special session at the URSI Meeting held in Montreal in July. The poor resolution results in part from the limited number of data points used in the inversion step. During this summer new work was carried out on a spectral estimation technique that can make use of prior knowledge about the target to improve resolution. It transpired that this approach was particularly effective at identifying support bounds on the actual target. These support bounds provided a better indicator of what the target was than the image derived from the same scattering data. This leads one to conclude that with a certain number of data points and a certain degree of detail in one's prior knowledge of a target set, one can determine whether the best course of action is to "shape" the target using a dynamic prior function, or to form an image. These latter observations were carried out using real data acquired from a model of a cruise missile. Being a metallic target, there was little multiple scattering and the inverse scattering aspect of the identification step was not demanding. Future work will focus on folding the spectral estimation step into the cepstral filtering algorithm in order to identify penetrable targets using very little backscatter data.

KINETIC STUDY OF THE THERMAL DECOMPOSITION
OF *t*-BUTYLPHENYL PHOSPHATE USING THE
SYSTEM FOR THERMAL DIAGNOSTIC STUDIES (STDS)

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Abstract

The System for Thermal Diagnostic Studies (STDS), which links a thermal

reactor cell directly to a gas chromatograph/mass spectrometer (GC/MS), allows one to

examine the gas phase decomposition of materials as a function of temperature, time, and

atmosphere. Tertiary-butylphenyl phosphate (*t*-BPP) shows some potential for use in

lubricants which must function at high temperatures. The decomposition of *t*-BPP was

studied at temperatures between 300°C and 700°C, rate constants were measured, and an

activiation energy for the decomposition was calculated.

ADVANCES IN BIOLOGICALLY-BASED KINETIC MODELING FOR TOXICOLOGICAL APPLICATIONS

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Abstract

Several physiological processes have been modeled and incorporated into existing pharmocokinetic models of the perfused rat liver. The kinetics of binding to proteins, membrane transport via a 4-state carrier, and the presence of serial capillary compartments in a liver have been modeled. One of the new features, protein binding kinetics, was explored through an experimental study of isolated perfused rat livers in which bromosulphophthalein (BSP) uptake and excretion was monitored at 3 different concentrations of albumin in the perfusion medium. The results indicate that the total uptake rate of an organic anion such as BSP is affected by its rate of dissociation from the protein albumin. This finding is in contrast to the usual assumption that dissociation from a protein is much faster than transport through a membrane and therefore has a negligible effect on total uptake rate.

Multiscale Material Characterization and Applications

George N. Frantziskonis

Abstract

Given the hierarchical structure of engineering materials, it is natural to seek multiscale characterization tool. This study explores wavelet analysis, a recently developed mathematical tool, for this purpose. In particular, the following problems are studied on an exploratory basis: (a) multiscale characterization of corrosion fields in aluminum alloys; (b) multiscale microstructure characterization of certain Titanium alloys; (c) discrimination of a fretted metal surface from an unfretted one using optical patterns from laser scattering. For the first problem, digitized microradiographs of corrosion in 0.74 mm Al samples with different projection magnifications (same optical magnification) are used. Through wavelet synthesis of the data at various scales, it is shown that it is feasible to obtain a quantitative measure of the corrosion field. Notably, wavelet analysis showed some periodic patterns in the images that were undetectable by the naked eye. The nature of these patterns is now being studied, yet, preliminary examinations show that they are the result of data processing and of the image capturing techniques used. It is imperative that such periodicity is understood and either eliminated or filtered out from the images. For the second problem, ultrasonic B-scan data are used for multiscale characterization of various Ti 6-4 microstructures. Two such microstructures are studied in detail for the purpose of quantitative characterization as well as for extraction of microstructural features from the B-scan data . For the third problem, preliminary results show that the optical scattering patterns should be obtained in a consistent manner, and possibly higher frequency laser beams should be used. Here, "consistent" concurs to using a fixed angle between the laser beam and the metal surface, and using the entire scattering pattern rather than pieces of it.

SYNTHESIS AND CHARACTERIZATION OF METAL-XANTHIC ACID AND -AMINO ACID COMPLEXES USEFUL AS NONLINEAR OPTICAL (NLO) MATERIALS

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Abstract

Several metal complexes of xanthic acid and amino acids were synthesized by the reactions of metal chlorides or acetates with potassium salt of xanthic acid or amino acids. The isolated compounds were characterized by IR-spectroscopy and elemental analysis. The nonlinear optical properties of these complexes were also investigated using Kurtz powder test. The complexes containing the xanthate ligands, namely $Cd(S_2C-O-CHMe_2)_2$, $Cd(S_2C-O-C_2H_5)_2$ and $Pb(S_2C-O-CHMe_2)_2$ were found to show strong second harmonic generation intensities. The other xanthate complexes, $Zn(S_2C-O-CHMe_2)_2$ and $Sn(S_2C-O-CHMe_2)_2$, failed to show SHG signals. On the other hand, the amino acid complexes, Zn-L-carnosine and Cu-L-carnosine, showed no SHG, although L-carnosine is NLO active and contained a chiral center in its molecular backbone. Of all the synthesized complexes, the xanthate complexes of cadmium and lead are identified as promising candidates for frequency doubling.

FOCAL POINT ACCURACY ASSESSEMENT OF AN OFF-AXIS SOLAR CONCENTRATOR

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Abstract

A solar propulsion vehicle (SPV) consists of three principal components: thruster, concentrator, and support structure. An important function of the support structure is to maintain the reflected solar energy inside the thruster cavity during all on-orbit maneuvers and environmental conditions. A finite element analysis is conducted to assess the ability of support structures, of a 1574.8x1181.1 inches (40x30 meters) off-axis parabolic concentrator, to achieve this function. The combined effects of the thrust required to change orbit, the aerodynamic drag at low earth orbit, and the on-orbit thermally-induced deformations are considered in the investigation. Two kinds of support structure/concentrator arrangements are investigated: inflatable concentrator with a support torus, and a foam-rigidized concentrator with no torus. The analysis indicates that the inflatable concentrator arrangement satisfies the required focal point accuracy, and that the rigidized concentrator arrangement does not. The rigidized concentrator concept, though attractive and promising, is too flexible and needs a substantial stiffening. For a sound design, a rigidized concentrator with a support torus is suggested, and addition of a partial passive damping to the supporting struts is recommended.

DESIGNING PROPULSION RELIABILITY
OF SPACE LAUNCH VEHICLES

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Abstract

The propulsion reliability of a thrust-augmented Single Stage to Orbit (SSTO) space launch vehicle depends on the number of solid boosters, the number of liquid engines, the reliability per solid booster, and the reliability per liquid engine. We give mathematical expressions of such dependence when the reliability does or does not depend on time. We present numerical results and corresponding figures demonstrating the relationship between the propulsion cluster reliability and the motor/engine reliabilities of both solid booster and liquid engines. This paper shows how the propulsion cluster reliability can be tailored to match a desired vehicle reliability.

MIXING AND STREAMING OF A FLUID NEAR THE ENTRANCE OF A TUBE DURING OSCILLATORY FLOW

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Abstract:

Fluid dynamic mixing and streaming phenomena are described near the end of a semi-infinite, rigid, straight circular tube containing an incompressible Newtonian fluid. For the specific problem considered, the entrance condition flow profile resembles the sinusoidal oscillations of a flat piston at the end of the tube. Solutions to a linear approximation, involving time-harmonic Stokes flow, are obtained. The solutions to this linear approximation for velocity components and pressure are given as superpositions of developed-flow solutions plus entrance-flow solutions. The entrance-flow solutions describe entrance-flow patterns in which radial velocity components and axial velocity gradients exist near the end of the tube. These entrance-flow velocity terms decay with distance from the end of the tube. The solutions to the linear problem serve as the first-order results. These linear time-harmonic results are substituted into the nonlinear terms of a higher-order approximation to the Navier-Stokes equation, the resulting equations contain products of sinusoidal-oscillating first-order terms. These products can be equated to combinations of second-harmonic velocity oscillations in addition to time-independent steady velocity terms. These time-independent terms describe steady bi-directional streaming motion near the end of the tube. Additionally, the linear, zero-order solutions reveal a mixing phenomena with swirling secondary flow near the end of the tube.

REDUCTION AND ANALYSIS
OF LDV AND ANALOG RAW DATA

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ABSTRACT

The laser Doppler Velocimeter (LDV) data analysis software used by the experimental research branch at Wright Laboratory (WL/POPT) was found to be deficient in some ways. Two new LDV data analysis software programs were developed to resolve these deficiencies. The programs named PACE2ASC and PACESTAT were written in the FORTRAN language so that they could be easily modified and recompiled at WL/POPT. Both programs read TSI PACE 1.2 acquired raw laser Doppler velocimetry files. This task first requires decoding the header information file produced by the LDV software; a task that was made extremely difficult because the header portion of the data file is of variable length. The header file length depends on the file name length, user input parameter name lengths, the number of "C" words recorded and the number of data windows selected by the RMR hardware. Once the header file is decoded the raw LDV and analog data words can be converted to velocities and signal levels. The first program, PACE2ASC, reads the TSI PACE 1.2 raw data files and writes the velocities, time between data word, RMR time word and the analog "C" words to a formatted ASCII file having the same family name as the raw data file but with the ASC extension. This program can batch process up to 10000 files at one time. The second program, PACESTAT, reads the TSI PACE 1.2 raw data files and calculates turbulence statistics up to the third moment for mixed turbulence quantities and up to the fourth moment for homogeneous turbulence quantities for up to three velocity components. A batch processing capability has been included so that up to 10000 files can be processed during each execution. A menu screen allows the user to select various run time options. In addition, it constructs and prints automatically scaled histograms of velocity PDFs with a labeled summary table of all pertinent information. These histograms and summaries can be formatted to print as an ASCII file, a postscript file or a Hewlett Packard PCL 5 file. Turbulence statistics are written to three formatted data files for later use by plotting routines or analysis programs. These statistics can be normalized with a constant reference velocity or can be normalized with different reference velocity for each data point processed during the batch job by reading a user created file which contains the reference velocities for each data point. Prior to calculating the turbulence statistics, data points lying outside of ±3 standard deviations are discarded. This default value of 3 can be overridden by the user at run time. The program allows for three velocity bias corrections, allows for non-orthogonal laser beam angle correction, and calculates the statistical uncertainties for all quantities using the jackknife method. Lastly, the user can override the fringe spacing, frequency shift and laser wavelength in the raw data files by reading a user created file which contains the correct values for these parameters. The source code was delivered to the scientists at WL/POPT.

Structure and Function of an
Extremely Sensitive Biological Infrared Detector

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Abstract

Highly-sensitive image-forming infrared detectors are found in boid and crotalid species of snakes. These infrared-detecting systems are superior to all artificial and all known biological infrared detectors, as they combine 0.003°C thermal resolution, microscopic size, and self-repair in an uncooled system. I have performed a detailed analysis of the infrared receptor system in the boid snakes *Python molurus bivittatus* (the Burmese python), *Python regius* (the royal python), and others. Surface structural analyses of the infrared-sensitive pit by transmission electron microscopy, scanning electron microscopy, and atomic force microscopy reveal an array of plate-like structures covered by regular arrays of "micropits." These micropits were also found on the spectacle covering the eyes, but their arrangement and size there were significantly different. Infrared spectrometry of this surface material from the IR-sensitive pits showed that it was completely non-reflective of IR from 2-15μm. This material readily transmitted IR in 2 major bands, centered on 4 and 10μm. IR imaging showed that the IR-sensitive pits were non-reflective and absorptive in both the 3-5μm and 8-12μm ranges; both of these parameters were greater in the 8-12μm band. These results are particularly interesting in that these snakes normally target endothermic mammalian prey radiating maximally at 10μm. Since phosphate absorbs at 10μm, and since protein phosphorylation is an important and ubiquitous component of sensory signaling, we began biochemical analyses of tissue containing the IR-sensitive neuronal terminals. Polyacrylamide gel electrophoresis showed that the IR-sensing pits contain a variety of proteins, and that the protein pattern is distinct from that in non-pit skin, retina, and brain. Affinity chromatography successfully isolated several phosphoproteins from tissue homogenates. Immunohistochemistry on the IR-sensitive neuronal terminals showed that they are distinct from photoreceptors in the retina, in that they lack both the protein opsin and 2 calcium-binding proteins, calretinin and calbindin. However, they do contain 2 unique calcium-binding proteins, calmodulin and S-100, both of which may be involved in IR transduction, and the activities of which are regulated phosphorylation. Together, these results show that (1) IR-sensitive pits in *Python* contain an unusual surface architecture which may impart unique optical properties, (2) these pits maximally absorb in the 8-12μm range, matching the peak emission of targeted prey, and (3) IR-sensitive neuronal terminals are biochemically distinct from visible light-absorbing retinal photoreceptors, non-pit skin, and brain. Finally, these results provide a strong basis for the continued isolation and analysis of the biochemical components responsible for highly sensitive uncooled IR detection. This work may ultimately allow development of new infrared imaging technologies that take advantage of the positive features of snake infrared detectors.

Indicial Response Model for Roll Angle and Roll Rate Effects on a Delta Wing during Forced Roll Oscillations

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Abstract

This paper describes an indicial response model for predicting the rolling moment on a 65° delta wing experiencing harmonic oscillations in body-axis roll at moderate to high rates. The model is formulated in the aeroballistic coordinate system and comprises two convolution integrals with one integral accounting for variations in roll angle and a second integral accounting for variations in roll rate. The model is semi-empirical in that the indicial responses are computed from experimental wind tunnel data using an optimization method. The model is extended to a nonlinear model which accounts for static nonlinearities. The nonlinear model is used to predict the moment for both harmonic rolling motions and ramp motions.

AN OBJECT-BASED APPROACH FOR INTEGRATING COST ASSESSMENT INTO PRODUCT/PROCESS DESIGN

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ABSTRACT

The design, development, and manufacture of affordable products is a major concern in both military and commercial production. One critical element in designing affordable products is the concurrent consideration of product and process cost early in the design process. This research provides an approach for integrating cost assessment into the product/process design environment. The underlying concept is based upon the simultaneous consideration of the components of the product triad – form, material, and process – through the application of object-oriented technologies. This paper (1) provides a conceptual representation of an object-based, cost-assessment approach that supports the design process, (2) defines the objects, properties, hierarchies, and underlying object structure that are used in the approach, and (3) describes an initial view of the application environment and software that would be used to implement the approach as a design support system.

RANGE ESTIMATING FOR RESEARCH AND DEVELOPMENT ALTERNATIVES

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Abstract

This research was designed to assist Wright Laboratory Air Base Technology Branch in identifying limiting factors and cost drivers for emerging technologies. By identifying the limiting factors and cost drivers, technology developers can better focus their research to find alternatives to overcome limitations or to develop more "affordable" solutions in these times of decreasing budgets. As part of their Air Base facilities research, the Air Base Technology Branch has a long, successful history of developing telerobotic and autonomous construction equipment for rapid runway construction and repair and for remediating hazardous waste and unexploded ordnance. The specific request for this summer research was to develop a methodology to analyze these field data to identify limiting factors and cost drivers that in turn could be used to focus future research thrusts. These field data are results of complex, multivariate problems that include integration of telerobotic search operations; vehicle navigation; guidance and control; remote communications; global positioning links; automated damage assessment; automated target location, identification, and recognition; end effector integration; commercial off-the-shelf applications; and associated computer technologies. The methodology prototyped, after researching many alternatives, was an application of Artificial Neural Networks. This paper will discuss the alternative methodologies and the rationale for selecting Artificial Neural Networks. Complementing this paper are two graduate student papers to complete this summer research project: "Cost-Based Risk Predictions and Identification of Project Cost Drivers Using Artificial Neural Networks" (Pearce 97-0415) and "Data Simulation Supporting Range Estimating for Research and Development Alternatives" (Williams 97-0416).

A DYNAMICAL SYSTEM APPROACH
IN BIOMEDICAL RESEARCH

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ABSTRACT

The purpose of this project is to develop statistical methods in order to improve the ability to make inferences from biomedical data using animals or human subjects. The biomedical data consist of immunological blood cell counts taken on two groups of animals; one group is exposed to radiation and the other group is not. It is assumed that these counts are associated with dynamical systems whose solutions are chaotic in nature. More specifically the cell counts are given by the dynamical system

$$p(t + 1) = c_1 p(t)(1 - p(t)) - c_2 p(t)$$

where $p(t)$ is the proportion of normal cell counts at time t, c_1 and c_2 are constants to be determined. However, the past data suggest that $3 < c_1 < 4$. We have a treated and a control group of animals with sample size N in each group. We are allowed to draw a blood sample from each animal. The main problem here is to examine the group differences taking into account the dynamical system described above. Further, one should compare the statistical approach that would have applied if it was not recognized that the dynamical system was at the basis of phenomenology.

In this project we study the structure of the dynamical system and develop some statistical models, incorporating the knowledge of the dynamical system to examine the group differences between the treated and the untreated group of animals.

ASYMPTOTIC ANALYSIS OF THE NATURAL SYSTEM MODES OF COUPLED BODIES IN THE LARGE SEPARATION, LOW-FREQUENCY REGIME

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Abstract

In this report we examine the natural electromagnetic system modes (characteristic frequencies and currents) of two coupled bodies in the limit of large separation. It is known that when objects are situated such that they may interact electromagnetically, natural modes of the coupled system occur. These modes differ from the natural modes of the isolated bodies, but may be related to the isolated body modes for some situations. Here we treat an N-body scattering problem in the limit of large separation by replacing the bodies with equivalent dipole moments. The natural frequencies are obtained as singular points in the scattering solution. For the special case of two coupled objects, a simple equation for the natural system frequencies is obtained which shows that the real radian system frequency approaches the origin as $1/r$, independent of the relative orientation and type of the two bodies. The damping coefficient approaches the origin approximately logarithmically, as a function of the body orientation and type. This simple equation leads to classification and ordering of some system modes based on their behavior in the limit of large separation. Using this formulation, the natural system modes of two coupled wires are investigated for large separation between the wires, and compared to an integral equation solution.

ANISOTROPY IN EPIC 96&97: IMPLEMENTATION AND EFFECTS

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Abstract

Computer simulations of high velocity impact events provide efficient and effective means for analyzing weapons and armor systems. Today this is true more than ever before with the continuing trend towards faster computers at lower cost. Hence computer codes which perform these simulations have become an indispensable tool to the present day weapons designer. The availability of higher powered computers has allowed these computer codes to be modified and expanded to model currently used materials in a more realistic way. Furthermore this has also provided the weapons designer with a chance to consider new and potentially more effective materials which respond to loading in a more complicated manner.

The computer code of interest here, termed EPIC (Elastic Plastic Impact Code), is a finite element based continuum hydrocode. Previous versions of EPIC have only included the capability to analyze isotropic materials. This isotropic constitutive model has worked well to study the behavior of currently used materials such as copper which exhibits minimal direction dependence in its properties. However materials of increasing interest to the Air Force in its weapons development program do not generally follow this isotropic behavior. One such material of particular interest to the Air Force is tantalum. The heavy compression that occurs during processing of this body centered cubic metal results in a preferred orientation of the grains referred to as texture. The presence of texture gives a directional dependence to the material properties which leads it to obey an anisotropic constitutive law.

Recent versions of EPIC (1996&97) have included the ability to analyze anisotropic materials, particularly in the post yield realm of material behavior. Hence it was the main focus of the present work to investigate the implementation of anisotropy in this hydrocode and to conduct an initial numerical investigation as to how significant are the effects of anisotropy. For the numerical analysis, simulations of the Taylor impact test were used. It is shown that anisotropy in the plastic deformation properties can have significant effects on high velocity impact. In particular quantities such as wave front position, effective stress and equivalent plastic strain, and strain rate can be substantially different as compared to isotropic materials.

FRACTURE ANALYSIS OF THE F-5, 15%-SPAR BOLT

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Abstract

The 15%-spar bolt that connects the wing to the fuselage of the F-5 airplanes was observed to fail in fatigue at a relatively short flight-time. Bending stresses developed at the base of the bolt allow for a fast crack growth. The bending stresses can be reduced if the tolerance between the bolt and the bushing is decreased. A boundary-element program was used to investigate the stress concentration factors and crack growth at the base of the bolt. The results of this analysis were fed into a damage-tolerance code to find time-to-failure for different tolerances between the bolt and the bushing. It was found that if the tolerance decreases from 0.012 inches to 0.003 inches the hours-to-failure increase from 1.800 to 50.000.

A MODEL FOR TURBULENCE AND PHOTODETECTION NOISE IN IMAGING SYSTEMS

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Abstract

A stochastic model is developed to describe image degradation due to turbulence and uncertainty in photodetection and intensification in gated imaging systems. The results of simulation indicate that real-time integration imaging results in a superior performance than frame-by-frame averaging if the time between frames is relatively large. The effect of turbulence is modeled by assuming a slowly time varying random thin screen in the aperture plane which introduces a time-varying random tilt. The variation in the tilt, due to the change in the thin screen from frame to frame, can become large for sufficiently large times between frames. When images are averaged, simulations suggest that there is a tradeoff between the number of successive frames used and atmospheric blur. This tradeoff requires further research to optimize the exposure time for minimizing the mean square error. Reduction in the resolution and contrast due to the uncertainty in the response of TE photocathode detectors and MCP image intensifiers is also considered. A model has been developed that captures the degrading effect of dark current. Simulations show that when the MCP is operated in the saturation mode, dark current significantly reduces contrast. The model also captures the spread introduced by the MCP, electron focusing error. and the random multiplication gain associated with the MCP stages. Analytical expressions are derived for the mean and the variance of the point spread function of the intensifier. The model for the detection/intensification is combined with the model for turbulence to give a complete stochastic model for the imaging system.

The Study of Electrical Characteristics of CdS Passivation on InP

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Abstract

InP surface passivation has been realized by a convenient chemical bath deposition (CBD) of a thin CdS layer. For comparison, samples without any treatment and with only a thin SiO_2 layer were also prepared. Also studied was the effect of a thin layer of SiO_2 deposited immediately after the CdS deposition. Schottky contacts were made on the CdS-passivated InP by electron-beam deposition of Ti/Au. Electrical characterization was conducted by current-voltage (I-V) and capacitance-voltage (C-V) measurements. Atomic force microscopy was used for surface morphology studies. It was found that the electrical performance of the Schottky contacts of the CdS-passivated samples was improved significantly. The thickness (deposition time) of the CdS strongly affects the device electrical performance. The additional SiO_2-on-CdS layer plays an important role in the process of InP surface passivation. Post-treatment in the CdS deposition process also significantly improves the surface morphology and electrical properties.

NMR STUDY OF THE DECOMPOSITION REACTION PATH OF DEMNUM FLUID UNDER TRIBOLOGICAL CONDITIONS

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Abstract

It has previously been shown using ^{19}F nuclear magnetic resonance (NMR) spectroscopy that Demnum fluid undergoes decomposition by a disproportionation reaction mechanism to form acid fluorides when heated in the presence of aluminum chloride. It is shown in this study that Demnum fluid decomposes at 345C in the presence of dry air and bearing steels to form the same acid fluorides. Consequently, the same disproportionation reaction mechanism must be involved under these conditions as well. Then it is shown that these acid fluorides readily undergo hydrolysis to carboxylic acids when they are exposed to atmospheric moisture. Finally, carboxylic acids, not acid fluorides, were detected in highly stressed Demnum fluids exposed to the atmosphere after recovery from fatigue testing experiments. Therefore, it is concluded that under tribological conditions, Demnum fluid initially decomposes in the presence of bearing steels by a disproportionation reaction mechanism to form acid fluorides which subsequently react with atmospheric moisture to form carboxylic acids.

A PROTOCOL FOR DEVELOPMENT OF AMPLICONS FOR A RAPID AND EFFICIENT METHOD OF GENOTYPING HEPATITIS C VIRUS FROM CLINICAL SERUM SPECIMENS

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Abstract

The two goals of this research project were to (1) establish a procedure to confirm the presence of Hepatitis C Virus (HCV) in serum and (2) to establish a procedure to obtain unique amplicons suitable for genotyping HCV specimens. HCV detection needed to be simple and rapid for use in a clinical laboratory setting. Genotyping of HCV is necessary for further epidemiological studies and assessment of risk to military personnel deployed worldwide. This research examines two protocols for (1) a PCR-based assay to test for HCV RNA (antigen) and (2) isolating viral RNA and preparing cDNA for a PCR-based method for genetic typing of HCV variants. Our results indicate the potential for exploring novel applications of current technology to rapidly genotype HCV variants in the clinical laboratory setting. This work will continue throughout the year at the Institute of Molecular Biology and Medicine (University of Scranton) in collaboration with the Air Force Epidemiology Research Division (Armstrong Laboratory) and the University of Texas School of Public Health.

INTENSITY OF [111] AND [100] TEXTURAL COMPONENTS
IN COMPRESSION-FORGED TANTALUM

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Professor

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Abstract

Crystallographic textures in compressed tantalum were studied. A method has been devised to analyze the strength of the individual textural components in materials with fib er textures. Analyses of three batches of tantalum indicate that the final texture after forging is composed of [111] and [100] components. The relative strength of the two components depends on the texture before compression. Since the final mechanical properties depend strongly on texture, control of properties requires control of texture, including the starting texture. It is suggested that program to predict quantitatively the end texture from the starting texture would allow tighter control of the starting material.

A STUDY OF A DATA-PARALLEL IMPLEMENTATION OF AN IMPLICIT SOLUTION OF THE 3D NAVIER-STOKES EQUATIONS

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A preliminary parallel version of the FDL3DI application from Wright Laboratory was developed using MPI on an IBM SP2. This report describes the overall design of the parallel code and estimates the performance of the code. For this data-parallel implementation, a single grid is broken into subgrids and each subgrid is assigned to a separate processor. The boundary points are exchanged between processors as necessary. Parallel I/O features were written which produce identical results for sequential and parallel restart files, allowing restart files to be moved between sequential and parallel platforms.

This approach required extensive modifications to the source but allows for high levels of parallelism. Experimental runs show that the solution for a grid of size $140 \times 140 \times 140$ exhibits a speedup of 2.9 on four processors. These preliminary results demonstrate that parallel systems can provide significant performance improvements for this application.

Effects of Surface Scattering in 3-D Optical Mass Storage

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August 28, 1997

Abstract

In this work a problem of surface scattering of the light during 3-D optical recording is investigated on the basis of analytical solutions obtained using spectral approach. Results of analysis show that such effects become considerable if the averaged peak-to-peak surface error becomes greater then the half of the wavelength of the recording light. Both bit and binary image types of storage are considered.

Edem Ibragimov

DEVELOPMENT OF A CONCEPTUAL DESIGN FOR AN INFORMATION SYSTEMS INFRASTRUCTURE TO SUPPORT THE *SQUADRON XXI* INIATIVE FOR THE UNITED STATES AIR FORCE

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Abstract

Information processing and data delivery are crucial elements in the success of any modern organization. Squadron XXI is an initiative which is currently underway at Luke Air Force Base, Arizona, under the guidance and direction of the Air Force Research Laboratory at Williams Gateway Airport in Mesa, Arizona. The goal behind Squadron XXI is to develop and test a prototype information systems to permit all authorized users in their respective training and operational squadrons to access real-time information in support of their individual missions. The Squadron XXI information system requirements are being designed to satisfy current and future operational and training objectives for pilot training in the United States Air Force. Typical information requirements will cover scheduling and delivery of classroom instruction, simulator training, pre-flight, in-flight, and post-flight instruction, maintenance scheduling, weather data analyses, personnel qualifications, personal flight readiness certifications, and operational considerations under well defined, yet complex constraint sets. This study describes a conceptual information systems infrastructure for use at Luke Air Force Base and identifies the need for further detailed analyses to support current and future organizational and operational requirements for Air Force Pilot Training.

BLIND BAYESIAN RESTORATION OF ADAPTIVE OPTICS IMAGES USING GENERALIZED GAUSSIAN MARKOV RANDOM FIELD MODELS

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Abstract

This report introduces a blind method based on Bayesian maximum a posteriori (MAP) estimation theory for restoring images corrupted by noise and blurred by one or more unknown point-spread-functions (psf). The paper addresses post processing for resolution enhancement of sequences of short exposure (2-10 ms) adaptive optics (AO) images of space objects. In the problem formulation, both the true image and the unknown blur psf's are represented by the flexible generalized Gaussian Markov random field (GGMRF) model. The GGMRF probability density function provides a natural mechanism for expressing available prior information about the image and blur. Incorporating such prior knowledge in the deconvolution optimization is crucial for the success of blind restoration algorithms. For example, space objects often contain sharp edge boundaries and geometric structures, while the residual blur psf in the corresponding partially corrected AO image is spectrally band limited, and exhibits smoothed, random, texture-like features on a peaked central core. By properly choosing parameters, GGMRF models can accurately represent both the blur psf and the object, and serve to regularize the deconvolution problem. These two GGMRF models also serve as discriminator functions to separate blur and object in the solution. Algorithm performance is demonstrated with examples from AO images collected at the Starfire Optical Range, USAF Phillips Laboratory. Results from both real and synthetic data indicate significant resolution enhancement when applied to partially corrected AO images. An efficient computational algorithm is described.

MECHANICS OF SURFACE PRECISION FOR MEMBRANE REFLECTORS

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Abstract

The seminal application of membrane structures for space-based communications occurred over four decades ago with the Echo series of satellites. Today, a resurgence of interest in membrane structures for extraterrestrial use is developing, due to their potential for reduced launch mass and stowed volume. Applications for such structures range from planar configurations in solar sails, concentrators, and shields, to inflatable lenticulars for radar, radio, and optical uses. The performance of this latter class of applications is studied, with particular emphasis on the precision of the reflector surface.

An Innovative Segmented Tungsten Penetrating Munition

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ABSTRACT

One of the factors that governs the penetration depth of a penetrating munition is the ratio of the penetrator's weight to its cross-sectional area (W/A). Dense metal ballast significantly increases W/A, but yields some structural challenges. Tungsten, in particular, while being very dense, typically has low ductility and toughness in bulk form, and is difficult to fabricate and machine. The purpose of this work was to investigate the feasibility of developing a segmented dense metal ballasted penetrating munition. Allowing the use of segments greatly facilitates the manufacturing of the tungsten portion of the munition.

The use of a segmented ballast requires a strong, tough member to maintain structural integrity during impact. In this work, steel was considered for this purpose. Two configurations were considered: a steel rod, with tungsten rings placed around it, and a steel shell, with tungsten disks placed inside it. Both linear and non-linear structural and material response were considered, using analytical techniques. A 3-D finite element analysis was also initiated, but has not yet reached completion as of the submission of this report.

The analytical work suggests that a segmented tungsten penetrator is indeed feasible, and should be pursued. Using a non-linear structural and material response analysis, coupled with an empirical external loads model from a computer code called AMPLL, by William K. Rule, it was demonstrated that a representative segmented tungsten ballasted penetrator could withstand impact angles of up to about 20° off vertical ($\beta = 70°$), and angles of attack (α) of up to about 1°.

It was found that the shell configuration was more robust than the steel rod configuration. The members of the structure can be sized (with satisfactorily small amounts of steel in the cross-section) such that no permanent shape change occurs during impact. This means that not only will the structure survive impact, but that adverse terradynamic effects will be minimized.

Mode Conversion in a Time-varying Magnetoplasma Medium

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Abstract

The modification of frequency and field amplitudes of an extraordinary wave (X wave) by a time-varying magnetoplasma medium is considered. An explicit expression for the amplitude of the electric and magnetic fields in terms of the magnetoplasma parameters and the new frequency is obtained. Based on the qualitative results, one many conclude that the mode conversion takes place in the neighborhood of $\omega_b \approx \omega_o$.

MEASUREMENT OF THE CUTTING PERFORMANCE OF A HIGH BEAM QUALITY CHEMICAL OXYGEN-IODINE LASER ON AEROSPACE AND INDUSTRIAL MATERIALS

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Abstract

Chemical Oxygen-Iodine Laser (COIL) technology has received considerable interest over the last several years due to its short, fiber-deliverable wavelength (1.315 microns), scalability to high powers (tens of kilowatts, cw), and potentially high beam quality. Unfortunately, materials processing demonstrations to date have been performed with relatively small COILs producing very poor quality beams ($M^2 > 100$). This paper documents the cutting performance of a high beam quality COIL. Cut depth and width on a variety of materials is documented as a function of various process parameters. Also, the optical quality of the laser beam is evaluated in this study.

QUANTUM CHEMICAL CHARACTERIZATION OF THE ELECTRONIC STRUCTURE AND REACTIONS OF SILICON DANGLING BONDS IN Si/SiO$_2$. REACTIONS OF H$_2$ AND H AT THE SILICON (111) INTERFACE.

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Abstract

The finite cluster method is employed to calculate activation energies for the passivation/depassivation reactions of hydrogen with the dangling bond center at the (111) Si/SiO$_2$ interface. Initial results including only nearest neighbors do not reproduce the experimental values. It is shown that an accurate and reliable quantum chemical treatment is feasible for a large cluster model using a general "model within a model" approach. Possible further simplifications are discussed along with future applications and developments.

Synthesis Of Salts With Delocalized Anions
For Use As Third Order Nonlinear Optical Materials

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Abstract

The synthesis of molten salts from delocalized anions was studied for application as third order nonlinear optical materials. Sodium O-methylxanthate was synthesized and the sodium counterion was exchanged for 1-ethyl-3-methylimidazolium. Molten xanthate salts with butyl pyridinium counterion were prepared by a similar cation exchange. The resulting molten salts were characterized by NMR, IR, and UV-Vis spectroscopy. The molten salt with 1-ethyl-3-methylimidazolium counterion was found to display no observable freezing point above −195°C (boiling point of liquid nitrogen) by differential scanning calorimetry. A transition to a glassy solid was observed visually, but the transition temperature could not be detected by differential scanning calorimetry.

ORGANICALLY MODIFIED SILICATE FILMS AS CORROSION RESISTANT TREATMENTS FOR 2024-T3 ALUMINUM ALLOY

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Abstract

Organically modified silicates (ormosils) sol-gel films coated on aluminum alloy 2024-T3 coupons were investigated for the purpose of developing an environmentally-compliant replacement for chromate-based surface treatments. The effect of surfactants, hybrid organic content, and alkoxide size effects on resultant films were evaluated for corrosion protection in comparison to Alodine-1200 type surface treatments. Results indicate that pinhole surface defects were present in most films; these limit the ultimate performance of sol-gel treatments. Even with pinhole defects, however, 4 orders of magnitude improvement in corrosion protection was demonstrated for sol-gel treated coupons with respect to Alodine 1200 surface treatments. Selected single-layer sol-gel compositions were found to rival the performance of the chromate-laden paint system (e.g., Alodine/primer/topcoat) currently used by the Air Force.

Numerically Efficient Direct Ray Tracing Algorithms for Automatic Target Recognition using FPGAs

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Abstract

Numerically efficient direct ray tracing algorithms are developed in closed form to automatically recognize targets in hard real-time situations. The developed algorithms have been implemented in high level language C/C++ employing both fixed-point-only or floating-point-only operations. The new algorithms' accuracy and execution time speedup have been validated against various benchmarks utilizing both fixed-point and floating-point operation based C/C++ programs. Xilinx XC4000 FPGA based software-to-hardware mapping using VHDL has also been studied to rapidly and optimally implement the developed algorithms into hardware platform. The developed ray tracing algorithms are accurate. Numerically efficient, thereby, ideal for hard real-time automatic target recognition applications in the avionics environment.

ANALYSIS OF OPTICALLY ACTIVE MATERIAL LAYER FIBERS

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Abstract

We have analyzed both fibers having a thin AlCu alloy layer strip that covers about 15 degrees of arc at the core cladding boundary and fibers having a thin CdTe semiconductor layer cylinder at the core cladding boundary of the fiber. Both the AlCu alloy strip and the CdTe cylinder are about 5 nm thick. The AlCu alloy strip fibers have absorption resonance at 449 nm, 935 nm, and 1140 nm in the transmission spectrum and exhibit both a polarization sensitive absorption at 1140 nm and birefringence at 1320 nm. The CdTe fibers exhibit a step at a wavelength of 795 nm in the transmission spectrum. This step is shifted towards shorter wavelength from its value of 827 nm in the bulk material in the fiber preform.

A Function Approximation Approach for Region of Interest Selection in Synthetic Aperture Radar Images

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Abstract:

One of the first steps in Automatic Target Recognition (ATR) is the grading of an image to identify, for further analysis, candidate regions which may have potential targets. To be most effective, this initial detection (or focus of attention) stage needs to reject clutter (noise or countermeasures which provide target like characteristics), while ensuring regions with true targets are not missed.

This report outlines the procedure and some results obtained towards using the model order of an artificial neural network to characterize disjoint block in Synthetic Aperture Radar (SAR) images. The approach is based on the premise that regions with targets would require a model with more free parameters (higher model order) to approximate the distribution of the return. Consequently, we use recently developed neural network algorithms [17]-[20] *which can self-regulate their model order*, to approximate disjoint squares of the image. Squares of the image which require a larger model order (more free parameters) are then labeled as candidate regions likely to have potential targets.

Simulations from several target and clutter images from the MSTAR PUBLIC CD-ROMS were used to evaluate the efficacy of the proposed approach.

A SIMPLE, MULTIVERSION CONCURRENCY CONTROL PROTOCOL FOR INTERNET DATABASES

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Abstract

We present a concurrency control protocol that would be particularly suitable for large, distributed databases accessible via the internet. The main function of a concurrency control protocol is to make sure that the database remains consistent and coherent in spite of concurrent access to it by different users who are reading and updating it. Internet based distributed database systems have special requirements, e.g., having a large number of read-only transactions, and an expectation that such transactions should almost always be given a consistent set of data; letting a read-only transaction read an inconsistent set of data or only part of the data it needs, and later rolling it back is unreasonable--- especially when it is an interactive transaction involving a human user, since it is difficult and annoying for a human user to ``unlearn'' what he read previously. Many traditional protocols do not satisfy this expectation. Also, a read-only transaction expects a fast response time, so it should not be normally delayed or rolled back simply due to the peculiarities of the concurrency control algorithm being employed. Unfortunately, most traditional protocols would do just that ---. delaying a read-only transaction due to unavailability of certain locks or otherwise rolling it back for a variety of reasons. Also, some of the read operations by an update transaction may be ``useless'' in the sense that they won't influence the computation of write values by the transaction. For example, a user may surf other parts of the database just to get a general idea of the contents. Traditional protocols do not take advantage of these reads being ``useless'' (i.e., insignificant) in optimizing performance; they simply assume that all reads are used in computing the write values in ways unknown to the system. Our concurrency control protocol handles all these issues effectively. Moreover, our protocol is conceptually simple, and easy to implement. It is quite flexible, allowing several variations that can be used for performance enhancements or user convenience. For example, a transaction is free to check if a new version of the database has been created after its previous read operations, and hence it may wish to discard the older version and may read again from the newer version. On the other hand, sometimes a read-only transaction may indeed prefer to read an older version of the database even though newer versions are available. In terms of common classification of concurrency control protocols, ours is a *multiversion, optimistic* protocol.

H_2 REACTIONS AT DANGLING BONDS IN SIO_2

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Abstract

The hydrogen passivation reaction at the dangling bond on an E' center in SIO_2 is studied using the model reaction $H_2 + \cdot Si(OH)_3 \rightarrow \cdot H + HSi(OH)_3$. A study of the energetics of this reaction at the Hartree-Fock and MP2 level is presented with a variety of basis sets. Direct dynamics calculations are also performed to evaluate rate constants and activation energies for the process, with and without the inclusion of quantum tunneling effects. The results are compared to an experimental value for the activation energy of H_2 annealing of E' centers.

Excitation of Oscillating Two Stream Instability by Upper Hybrid Pump Waves in Ionospheric Heating Experiments at Tromso

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Abstract

It is shown that upper hybrid waves generated by the HF heater wave in the Tromso' heating experiments can excite oscillating two stream instability near the upper hybrid resonance layer of the heater wave. The sidebands of the investigated parametric instability are obliquely propagating Langmuir waves. These Langmuir waves can be excited in milliseconds and have a broad angular distribution. Thus, those waves propagating obliquely at small angles with respect to the geomagnetic field can contribute to the zero off-set frequency component of the plasma line spectrum detected by a backscatter radar. The analyses also show that the wavelengths of the Langmuir waves have an upper bound and consequently, explain why the zero off-set frequency plasma line has been detected by the EISCAT 933 MHz (UHF) radar, but not by the EISCAT 244 MHz (VHF) radar as reported in Stubbe et. al. [1992].

REPLICATION AND EXTENSION OF THE SCHMIDT, HUNTER, AND OUTERBRIDGE (1986) MODEL OF JOB PERFORMANCE RATINGS

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Abstract

The present study tested an extension of Schmidt, Hunter, and Outerbridge's (1986) model of relationships among cognitive ability and experience, job knowledge, job proficiency and supervisor performance ratings that augmented these traditional "can-do" determinants of ratings with additional "will-do" determinants in a sample of 838 USAF first-term enlisted airmen. Results indicated a) that effects of ability and experience on job knowledge were linear, not interactive, b) that different conceptualizations of "experience" (i.e., job vs. task experience) play somewhat different roles in influencing job knowledge, job proficiency, and supervisor ratings, c) general support for the mediational roles played by job knowledge and job proficiency, and d) that supervisors' performance ratings reflect both "can-do" (i.e., technical) and "will-do" (i.e., motivational) aspects of performance. Implications and directions for future research are discussed.

ON THE ANALYSIS AND DESIGN
OF GAIN SCHEDULED MISSILE AUTOPILOTS

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Abstract

The application of a recently developed methodology for gain scheduled control system synthesis to the design of a pitch channel missile autopilot is described. Conditions are given under which a nonlinear gain scheduled autopilot exists that linearizes to a prescribed family of linear autopilots designed over specified operating envelope. A combination of techniques are employed to satisfy these conditions. Nonlinear simulation results indicate satisfactory performance over the flight envelope.

Laboratory Studies of Ionospheric Plasma Effects
Produced by Lightning-induced Whistler Waves

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Abstract

Laboratory experiments have been conducted at MIT, using the student-built Versatile Toroidal Facility (VTF), to investigate the ionospheric plasma effects produced by lightning-induced whistler waves. Lower hybrid waves, generated by the lightning-induced whistler waves, can cause prominent plasma effects, such as the acceleration of electrons and ions and the spectral broadening of plasma waves. Two mechanisms by which whistler waves can generate lower hybrid waves are examined in the VTF experiments. One is the simultaneous excitation of lower hybrid waves and low-frequency mode waves by intense whistler waves (Lee and Kuo, 1984). The other is the nonlinear mode conversion of whistler waves into lower hybrid waves in the presence of short-scale field-aligned density striations (Groves et al., 1988). The effect of lower hybrid waves on the spectra of Langmuir waves are singled out for investigation. The results of laboratory experiments show that lower hybrid waves can beat with Langmuir waves to produce frequency-upshifted and frequency-downshifted Langmuir waves [Lee et al., 1997], broadening the spectra of Langmuir waves. The intensity of these beat waves, however, depends upon the angle of wave propagation with respect to the magnetic field.

BOUNDARY CONDITIONS APPLIED TO THE
FINITE VOLUME TIME DOMAIN METHOD
FOR THE SOLUTION OF MAXWELL'S EQUATIONS

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Abstract

In this report. we consider the application of the anisotropic perfectly matched layer (PML) absorbing boundary condition to the finite volume time domain (FVTD) method. At this point, the anisotropic PML has been applied to both the finite difference time domain method and the finite element method in the frequency domain; however, no work has been done for extending this method to FVTD. This report contains a review of FVTD applied to electromagnetics. It is followed by a review of the general theory of the anisotropic PML. Finally we formulate the PML for the FVTD method.

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Microcontroller-Based Implementation
of Adaptive Structural Control

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ABSTRACT

Microcontroller-based feedback algorithms were examined for applications in adaptive structural control. The feedback control algorithms consisted of tunable second-order filters that adaptively suppressed vibration by tracking the frequency of resonant modes. Two circuit implementations were considered: a purely digital design implemented on a microcontroller, and a digitally-programmable analog design implemented using a microcontroller and an analog active filter. The purely digital design, although requiring less components, was limited by the speed of the microcontroller and the lack of floating point arithmetic. An initial design consisting of one second-order filter was implemented at a sampling rate of 2 kHz, but the use of fixed-point processing limited the filter frequency to above 40 Hz. The limitations of the purely digital approach motivated the use of a digitally-programmable analog filter as the feedback compensator. Using a digitally-programmable analog filter as the feedback compensator eliminated problems due to processor speed and fixed-point arithmetic while maintaining the reconfigurability of the algorithm. A frequency-tracking filter was implemented using a frequency identification algorithm implemented with a phase-locked loop and a microcontroller. A circuit was built and several tests were performed on a beam with a variable tip mass. The control experiments demonstrated that the active damping achieved with a fixed filter would be reduced by a factor of three as the natural frequency of the beam varied 24 Hz to approximately 11 Hz, whereas the adaptive filter maintained closed-loop damping ratios between 14% and 20% over the same frequency range. Furthermore, the frequency-tracking algorithm was able to adapt to vibration in approximately 500 μs, making it a practical algorithm for transient vibration suppression.

DEVELOP AN EXPLOSIVE SIMULATED TESTING APPARATUS FOR IMPACT PHYSICS RESEARCH AT WRIGHT LABORATORY

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Abstract

The research task is intended to develop a simulated process that may be used to test different materials for resistance to failure from internal explosions. Theoretical derivations and analyses were made of the design of the test device. The equation for the stress intensity of multiple bar impact theory was evolved. The formula for reflective and transmitted stress intensity on varied areas for the impact was also derived. Three scaled down models were used to obtain pressure data in order to analyze the feasibility of the design, which will simulate the characteristics of the larger design. Various tests were conducted at Range A (Building 22B) of Wright Laboratory. An analysis was conducted in order to develop a full-scale model that will be eventually fabricated and tested.

A STUDY ON THE CROWDED AIRSPACE
—SELF ORGANIZED CRITICALITY

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Abstract

A crowded airspace involves large numbers of airplanes interacting with each other. In general, the dynamic behavior of the system is quite complex and conventional mathematical modeling is difficult. Here, a generic air traffic model is used to investigate the application of the notion of "self-organized criticality". The results show that a crowded air traffic system exhibits the characteristics of self-organized criticality.

EXPERIMENTAL VALIDATION OF THREE-DIMENSIONAL RECONSTRUCTION OF INHOMOGENEITY IMAGES IN TURBID MEDIA

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Abstract

Near infrared radiation for imaging tumors in tissue has been recently explored and investigated. In particular, to validate a novel FFT imaging reconstruction algorithm, we have performed experiments on tissue phantoms using a frequency-domain photon migration system. The system includes an amplitude-modulated laser diode, two radio frequency (RF) signal generators, an avalanche photo detector, and a lock-in amplifier. The tissue phantoms were made with inhomogeneities imbedded and were then scanned with the system at various RF frequencies. The data from the amplitude and phase measurements were analyzed using the FFT reconstruction algorithm. The reconstructed data show clear validation of the FFT algorithm and afford to localize inhomogeneities hidden in turbid media in three dimensions. In addition, based on the results, we present preliminary analysis on optimization of experimental parameters to obtain good-quality, reconstructed images with best experimental efficiency.

THERMOELECTRIC ENERGY CONVERSION
WITH SOLID ELECTROLYTES

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Abstract

Alkali-Metal Thermal-to-Electrical Converter (AMTEC) is a high temperature regenerative concentration cell which converts thermal energy directly into electrical energy. The efficient operation of AMTEC cell involves several challenging heat and mass transfer which have been investigated. The AMTEC cell consists of several sodium vapor tubes. The pressure drop is calculated for each node in order to calculate the total pressure drop through the tube. The flow equations are derived in continuum, free molecular motion and transition regimes. As expected the molecular flow regime is more challenging. We studied this regime with Dusty Gas Model (DGM). This approach is expected to remove the discrepancy between the observed data and the results predicted by this model. Some alternate to sodium as working fluids have been surveyed. Potassium seems to a viable candidate.

THE MIAMI CORPUS LATIN AMERICAN DIALECT DATABASE: CONTINUED RESEARCH AND DEVELOPMENT

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ABSTRACT

The work reported herein is a continuation of the research and development being carried out on the Latin American Spanish Dialect database collected in Miami in 1995 by Drs. Rekart and Losiewicz with a Rome Laboratory and Analytical Systems Engineering Corporation (ASEC) collection team: a digitally recorded database containing 228 speakers from 10 different Latin American countries, developed by the Speech Processing Group at Rome Laboratory to aid in continued research on the feasibility of automatic machine dialect recognition. This report summarizes the development of an extensive PC-based database documenting the detailed information about each speaker in the corpus, including: language background, dialect features and technical recording details for each speaker. It also summarizes the research that has been conducted with the database thus far, and the documentation and research issues that still need to be addressed in order to make maximum use of the information contained in the database, towards the eventual goal of developing automatic dialect recognition algorithms.

MEDIATING EFFECT OF ONSET RATE ON THE RELATIONSHIP BETWEEN +Gz AND LBNP TOLERANCE

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ABSTRACT

Research attempting to establish a relationship between human response to lower body negative pressure (LBNP) and +Gz acceleration has in general, disregarded the moderating effects of negative pressure and +Gz onset rates. Seventeen males (24-34 years) were tested in a seated LBNP chamber and received three pressure onset schedules of 0.067, 0.33, and 2.0 mmHg/s. Relaxed acceleration tolerance was assessed on a 6.1 m centrifuge using three gradual onset rates of 0.2, 0.05, and 0.01 +Gz/s. LBNP and +Gz tolerances were subjected to principle components (factor) analysis to investigate the underlying correlation structure. The factor model suggested a two dimensional solution consisting of an acceleration factor and an orthostatic factor. The general pattern of the factor loadings indicates the relationship between tolerances of the two forms of orthostatic stress (acceleration and LBNP) is a function of how fast each stress is delivered. The correlation between LBNP tolerance and acceleration tolerance increases as LBNP onset is increased, or +Gz onset is decreased. Although both LBNP and +Gz exposure can lead to eventual loss of consciousness, syncopal events associated with intolerance to either stress are a function of somewhat different cardiovascular mechanisms. There are however, specific situations where LBNP may constitute a viable substitute for +Gz.

VELOCITY FIELD MEASUREMENTS
USING FILTERED-RAYLEIGH SCATTERING

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Abstract

Investigations into Filtered Rayleigh Scattering for large scale velocity field measurements in AEDC high speed wind tunnels were initiated during the summer 1997 program. The injection seeded Nd:YAG laser was optimimized for measurements, refining the alignment and cooling system of the laser and assessing its temperature stability, tunability, mode hopping characteristics and other pertainent optical requirements. An iodine cell used in the collection optics was also constructed and tested in the laboratory. The main accomplishments of the research were assessment of the feasability and the difficulties in making measurements in large scale wind tunnels. Mainly, this was done to investigate and hopefully any problems encountered in a laboratory setting before a complete full scale run was attempted. The results indicate that filtered-Rayleigh scattering is a promising technique for tunnel applications and more work will be done in the coming year in making tunnel measurements feasable as well as improving measurement accuracy.

THE EFFECTS OF TASK STRUCTURE ON COGNITIVE ORGANIZING PRINCIPLES: IMPLICATIONS FOR COMPLEX DISPLAY DESIGN PRACTICES

Robert P. Mahan
Associate Professor

Abstract

The exponential growth of automated systems is generating demands for sophisticated display design protocols. In general, cognitive engineering practices provide display design solutions that enhance the operator's ability to manage and control complex systems. However, they often do so without adequate modeling of the cognitive system requirements for this process. In effect, while the task and display properties are well defined, the cognitive system of the user remains covert and hidden from the modeling process. This report illustrates that different cognitive organizing principles are induced by different task representations. Further, performance is dependent on the congruent mapping between task, display, and cognitive organizing principle of the operator. By externalizing the organizational principle used by an operator in a given task context, in theory one can develop representations and displays that are congruent with task and cognitive system.

DISTORTION COMPENSATION AND ELIMINATION IN HOLOGRAPHIC RECONSTRUCTION

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ABSTRACT.

I discuss the quantitative location of objects from holographic images when the reconstruction wavelength differs from the recording wavelength. The holographic image equations are interpreted in a way that clarifies the meaning of stereo pairs of holographic images and indicates how back projection methods can be used in holography to locate objects. Alternate methods involving the production of distortion free regions in the holographic image field during reconstruction, the use of self calibrating objects in the object field during recording, and triangulation, can be used to locate objects.

PRELIMINARY REPORT ON THE EFFECTS OF VARIETIES OF
FEEDBACK TRAINING ON SINGLE TARGET TIME-TO-CONTACT JUDGMENTS

Philip H. Marshall

Professor

Department of Psychology

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Abstract

This preliminary study examined the effectiveness of various forms of information feedback training on single target time-to-contact judgments. Following a baseline testing condition, 80 participants were divided into four groups for additional trials that included one of four feedback conditions: no feedback, verbal only, visual only, or both verbal and visual. After filler task activities involving verbal and mathematics skills, a retest was conducted with non-feedback trials. The results indicated that informative feedback conditions resulted in improved performance compared to the no feedback condition, and that, in general, moderate performance gains persisted until retest. It is suggested that there be further research in the development and evaluation of more effective training methods for time-to-contact and related dynamic vision and timing skills in a context that allows for repeated training and assessment trials.

HOW TO PROVIDE AND EVALUATE NETWORK SECURITY

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Abstract

Because of universal connectivity to Internet, computer network security has become urgently important. This is a study of what is desired, and how security can be provided. Big corporations have been installing so-called network firewalls. Smaller organizations are yet to realize the implications. We propose an evaluation methodology that gauges the effectiveness of a security solution package. We also suggest security fortifications for individuals running Windows95 or Linux on their PCs.

A MOLECULAR ORBITAL THEORY ANALYSIS OF OLIGOMERS OF 2,2'-BITHIAZOLE AND PARTIALLY REDUCED 3,3'-DIMETHYL-2,2'-BITHIAZOLIUM CATIONS

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Abstract

The geometry of model compounds for poly(2,2'-bithiazole) (**PBT**), poly(3,3'-dimethyl-2,2'-bithiazole) (**PMBT**), and reduced **PMBT** were optimized at the AM1 level. Electronic transitions were computed using ZINDO/S. By extrapolation, **PBT** and **PMBT** were predicted to have λmax values of 702 and 546 nm, respectively. Fully reduced **PMBT** showed no chain length dependence as expected. Significant charge delocalization was observed for some mixed valent oligomers as evidenced by shift of λmax into the near-IR.

SOME OBSERVATIONS ON TARGET RECOGNITION USING HIGH RANGE RESOLUTION RADAR

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Abstract

Four topics involving target recognition using high range resolution (HRR) radar are considered. The first topic considers target recognition using the raw radar return (transform of HRR profile) rather than the HRR profile itself; the second topic considers what target recognition potential, if any, resides in the phase component of the HRR profile; the third topic considers the usefulness of a new template feature called the "histogram matrix." The final topic is the application of forward dynamic programming to the multiple aspect angle processing problem. The four investigations provide interesting insights and potentially useful results for the overall recognition problem.

A PROPOSED EXPERT SYSTEM FOR
ATS CAPABILITY ANALYSIS

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Abstract

Automatic Test Systems (ATS) are used by the Air Force and throughout the Department of Defense (DoD) to assist in the integrated diagnosis of weapon systems. The large amount of complex information available on each of the 617 ATS's in the Air Force inventory makes it necessary to have some automated means of accessing and evaluating the relevant information in order to accurately assess the overall Air Force ATS capability. The proposed system named ATS Comparative Evaluation Expert System (ACEES) will give the Air Force a new automated tool to meet the ever growing demand for efficient information management. This final report will outline the motivation and high-level design of ACEES as well as plans for the establishment of an ongoing research program designed to support and extend ACEES initial capabilities.

DELISTING OF HILL AIR FORCE BASE'S
INDUSTRIAL WASTEWATER TREATMENT PLANT SLUDGE

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Abstract

The US Air Force has set an environmental goal of 50% reduction of hazardous waste disposal by December 31, 1999. To meet this objective, Hill Air Force Base (Hill AFB) desires to delist its industrial wastewater treatment plant (IWTP) sludge which represents the largest single hazardous waste stream generated by the base.

The first step towards IWTP sludge delisting involved a legal review of both the code of federal regulations (CFR) and recent court rulings pertaining to industrial hazardous wastes. The results of this effort indicated that, since the IWTP sludge is produced by treatment of commingled wastewaters, it is not a "listed" hazardous waste under the Resource Conservation and Recovery Act (RCRA).

The second step toward sludge delisting involved conducting a metal material balance around the IWTP to identify the major sources of cadmium and chromium which impart the hazardous "characteristics" to the IWTP sludge. Results of the material balance indicated that the major sources of cadmium and chromium to the IWTP sludge were the following flows: 1) Building 505 Main Flow, 2) Building 505 Cyanide Flow and 3) Carboys from Buildings 505 and 507. To demonstrate to the regulatory authorities that delisting of the IWTP sludge does not diminish protection of human health and the environment, future pollution prevention (P2) efforts at Hill AFB should be directed towards reducing the metals loadings from these flows.

TESTING PROTOCOL FOR THE DEMILITARIZATION
SYSTEM AT THE EGLIN AFB HERD FACILITY

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Abstract

A sampling and testing protocol was developed for evaluating the three-stage wastewater filtration system and slurry feed injection system to the molten salt destruction unit at the High Explosive Research and Development (HERD) demilitarization facility at Eglin Air Force Base in Florida. Both systems are to be evaluated for their effectiveness in treating the wastewater and high explosive solids. The wastewater or "pink water" generated from washing out warheads will be treated by a three-stage filtration system consisting of sand filters, a fabric filter, and activated carbon filters so that it can be reused in the high-pressure water washout system. The slurry containing high explosive material will be oxidized to carbon dioxide, nitrogen and water vapor using the molten salt destruction process (MSD). Grab samples will be collected on the influent and effluent wastewater streams to the sand filters, fabric filter, and activated carbon filters. It is anticipated that approximately 99 percent of both the influent suspended solids and organic material as measured by chemical oxygen demand (COD) will be removed by the three-stage filtration system. Various air flow rates, slurry injection rates, and slurry compositions will be evaluated using the feed system test apparatus (FSTA) so that optimum rates can be determined to prevent plugging of the slurry feed injection tube to the molten salt destruction process. The molten salt destruction process is expected to achieve greater than 99.9 percent oxidation of the organic components in the slurry to carbon dioxide and water.

EXTENSION AND INSTALLATION OF THE MODEL–INTEGRATED
REAL–TIME IMAGING SYSTEM (MIRTIS)

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Abstract

MIRTIS (Model Integrated Real-Time Imaging System) has been developed during the past 5 years through a joint effort between Vanderbilt University and Arnold Engineering and Development Center (AEDC), with support from the Air–Force Office of Scientific Research (AFOSR). MIRTIS is a real–time image processing development environment which employs Model–Integrated Program Synthesis (MIPS) techniques for generating real–time image processing applications to be executed on a parallel hardware architecture. MIRTIS is capable of creating very high performance parallel implementations of a large class of image processing computations from high–level graphic specifications (models) of the system. These include models of the computations to be performed, the available resource, and the timing constraints of the application. From these graphical system models the MIRTIS *model interpreter* automatically parallelizes the computations using a two–level decomposition technique, scales the parallelism, and allocates the scaled decomposition to the available parallel hardware architecture (a network of Texas Instruments TMS320C40 DSPs) such that the resulting implementation will meet the specified timing constraints.

During the 1997 RDL/AFOSF Summer Faculty Research Program, the capabilities of the MIRTIS system were extended to enable MIRTIS to be used as an off–line compute server for reducing and enhancing large archived image data sets, as well as the real–time video applications for which it was originally designed. This required extensive modifications to several MIRTIS components (see figure 1), including the host interface programs, the Pipeline Cut–Through (PCT) run–time system (the kernel that runs on the C40s) and the Multigraph–Architecture (MGA) components of the system (the graphical model editor and model interpreter). The new system was installed, and a manual set was written so that AEDC personnel can use and extend the algorithmic capabilities of the system.

A USEFUL BENCHMARKING METHOD
IN COMPUTATIONAL MECHANICS, CFD,
AND HEAT TANSFER

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Abstract

A procedure for efficient benchmarking of computer solutions in the fields of computational mechanics including computational fluid mechanics, heat transfer, and k-ε turbulence models is presented. It consists of using assumed solutions to calculate the required source terms and use the resulting source terms as inputs to back calculate the displacements, velocities, temperature, etc. The procedure works for nonlinear problems also. Examples are provided from elasticity, Navier-Stokes equations, nonlinear heat conduction, convective heat transfer, and k-ε turbulence modeling.

SIMULATION OF A ROBUST LOCALLY OPTIMUM RECEIVER IN CORRELATED NOISE USING AUTOREGRESSIVE MODELING

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Abstract

This report presents the simulation of a robust *locally optimum* (LO) non-linear spread spectrum receiver. The signaling environment consists of the desired received signal in correlated interference and thermal noise. Autoregressive (AR) spectral modeling methods and a histogram approximation of the probability density function are employed. Preliminary results for transmission in the presence of *continuous wave* (CW) and *partial band* (PB) interference are presented and discussed. A comparison of this method to a similar nonlinear processing algorithm is performed. Preliminary results for the performance of a binary phase-shift keyed communications system indicate that applying AR modeling to the environment improves performance substantially, especially in the case of partial band interference.

THE DETECTION OF COLOR BREAKUP IN FIELD SEQUENTIAL COLOR DISPLAYS

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Wright State University

Abstract

Field-sequential color displays are of interest because of the need for small, high resolution color displays. Under many conditions, these displays suffer from the drawback that color breakup is perceived when the eyes are moved, a stimulus on the display is moved, or the display moves. Experiments were performed to determine thresholds for color breakup as a function of observer adaptation level, stimulus contrast, and the retinal velocity of the stimulus. The data were used to develop a model based on the spatial and temporal properties of the color coding mechanisms in the human visual system. The purpose was to develop a model that could be used to predict the detectability of color breakup in sequential color displays under a wide variety of viewing conditions.

Study of Nonlinear Dynamics in a Diode Pumped Nd:YAG laser

Tim Newell

University of New Mexico

Abstract

Nonlinear dynamics are investigated in a specially designed and constructed pump modulated Nd:YAG laser. The laser operates in single longitudinal and transverse mode as well as in one polarization eigenmode. Investigations reveal that a chaotic state can be obtained. The route into chaos is not characterized by a sequence of period doubling cascades but rather as an apparent crisis. Coexisting attractors are also observed.

RAPID PCR DETECTION OF VANCOMYCIN RESISTANCE OF *ENTEROCCUS* SPECIES IN INFECTED URINE AND BLOOD

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Abstract

Resistance of pathogenic bacteria to antibiotics is a rapidly growing problem in the U.S. and around the world. Several species of bacteria are developing resistance to many of the previously effective antibiotics, including vancomycin. This is especially a problem with *Enterococcus* species, which cause blood and urinary tract infections. In this study, a rapid method for recovery of bacterial DNA from urine or blood samples, coupled with the polymerase chain reaction (PCR) and analysis of the presence of vancomycin resistance genes by Gene Comb™ technology was optimized. This method could also be used to distinguish between *E. faecium* and *E. faecalis* in blood and urine samples, as well as provide rapid determination of the presence of either of these species and/or vancomycin resistance in less than 6 hours. It is also possible to determine the individual presence of *van*A, *van*B, *van*C-1, *van*C-2 or *van*C-3 genes in samples, an ability which may be applicable to other pathogenic organisms such as *Staphylococcus aureus*. Traditional clinical laboratory identification of *Enterococcus* species and vancomycin resistance typically requires several days. In serious infections this time factor may be very critical for patients, and thus this new method has great potential for assisting in the prompt and proper treatment of these bacterial infections.

MICROWAVE HOLOGRAPHY
USING INFRARED THERMOGRAMS OF ELECTROMAGNETIC FIELDS

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Abstract

An infrared (IR) imaging technique for measuring electromagnetic (EM) fields is being developed to map two-dimensional EM field distributions near a radiating antenna or a scattering object. The magnitude of the field is determined by measuring the temperature distribution (due to Joule heating) developed in a thin lossy 2D detector screen placed in the region over which the field distribution is to be measured. The measured temperature distribution is presented as an IR thermogram, i.e. as an equi-temperature contour plot, which can be interpreted to yield the value of the field intensity incident on the screen. The phase of the electric or magnetic field can also be determined with this technique using holographic interference techniques.

The measured phase, in conjunction with the measured magnitude of the field, is being used to determine the radiation pattern of an antenna-under-test (AUT). The phase is measured in the near field of the AUT. Two different techniques for phase-retrieval from magnitude only data are being developed. One technique extracts the phase from the IR thermogram using an iterative "Plane-to-Plane" (PTP) 2D Fourier Transformation convergence method. The other technique extracts the phase from the magnitude only data based on holographic interference patterns developed between the AUT and a known microwave reference antenna standard. The reference standard is being supplied and calibrated by the National Institute of Standards & Technology (NIST/Boulder) through a cooperative partnership with the University of Colorado at Colorado Springs (UCCS). The advantages and disadvantages of these two holographic techniques , viz. their inherent accuracies, are being determined and compared.

Numerical algorithms are being developed to collect and process the holographic data. The original numerical algorithms were developed at and in conjuntion with NIST/Boulder. Calibrated magnitude and phase data on the reference antenna also were measured at NIST/Boulder. The codes were further refined and enhanced at RL.

In the PTP method, two IR thermograms are made several wavelengths apart in the radiating near-field of the AUT. In the holographic interference technique, four holograms are made at one near-field location, one for the magnitude of the AUT only, one for the magnitude of the reference antenna alone, and two interference patterns with different phase shifts between the reference antenna and the AUT. These data can be processed to determine the complex intensity (magnitude and phase) of the field at any distance in front of the AUT (including the aperture plane).

GAIN SPECTRA OF BEAM-COUPLING IN PHOTOREFRACTIVE SEMICONDUCTORS

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Abstract

Photorefractive recording dynamics of two-beam coupling in semi-insulating semiconductors by beams with slightly different frequencies is studied theoretically and experimentally. The influence of bulk absorption, Gaussian beam profiles, and experimental geometry on the temporal response are analyzed. These effects act to narrow the bandwidth. Measurement of the material photorefractive time constant is discussed.

GROUP DIFFERENCES IN PERCEIVED IMPORTANCE OF SWAT WORKLOAD DIMENSIONS: EFFECTS ON JUDGMENT AND PERFORMANCE IN A VIRTUAL HIGH WORKLOAD ENVIRONMENT

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Abstract

The Subjective Workload Assessment Technique (SWAT) is a numerical conjoint scaling procedure that is used to construct estimates of workload scales for individuals or groups and importance estimates of time load, effort load, and stress load in determining workload. SWAT scales were constructed for 124 individuals who were found to fit one of six "workload prototype" groups on the basis of a cluster analysis of their importance weights. Individuals were then placed into three different virtual environment scenarios for which the task had either a high time, high mental effort, or high stress load component, respectively. Workload judgments and performance scores were obtained for each scenario. Results indicated that how individuals weighted the dimensions of workload (i.e., what prototype groups they were associated with) affected different reactions to each scenario on both their judged workload for the scenarios and on their performance measures. Implications for the use of separate workload prototype groups in workload research are discussed.

Software Verification Guide
Using PVS

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Abstract

This technical report will detail some of the syntax and semantics of the Prototype Verification System (PVS) used on several examples. It will include the specification and verification of the existence of a linear limit and a simple traffic light. A survey of several of the PVS prover commands and their applications will be taken to act as a guide to introduce Software Specification with PVS. Observations of employing PVS to aid in the co-design of complex systems will also be reviewed.

JOINT DOMAIN SPACE-TIME ADAPTIVE PROCESSING WITH SMALL TRAINING DATA SETS

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Abstract

The classical problem of optimum detection of a signal of unknown amplitude in Gaussian noise is revisited. The focus, however, is on adaptive system designs through limited training sets. Traditionally, adaptive detectors involve the inverse of the sampled covariance matrix of the noise process. In this work, linear filter optimization is carried out on a complex hyperplane and in the adaptive form no sample matrix inversion is necessary. This results in computational savings of an order of magnitude and superior probability of detection performance for small training set instances. An interesting by-product of the algorithm developed herein is significant test resistance when training data include the signal of interest.

While the issues treated refer to general adaptive detection procedures, the presentation is given in the context of joint space-time adaptive processing for array radars.

A Model to Attain Data Integrity After System Invasion

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Abstract

The objective of defensive information warfare is not only to prevent the system from malicious attackers, but also to detect such attacks when they occur and then to recover the system from the damage made by the attackers. This research is based on the assumption that the system under consideration has been attacked and the attack has been detected. A technique called data dependency has been developed that precisely determines the damage and recovers the system to a consistent state. The model achieves significantly improved efficiency over traditional transaction dependency approach.

PREPARATORY WORK TOWARDS A COMPUTER SIMULATION OF ELECTRON BEAM OPERATIONS ON TSS 1

Michael J. Pangia
Associate Professor
Department of Geology & Physics
Georgia Southwestern State University

Abstract

This work is the first stage towards a Particle-In-Cell simulation that will be used to explain the low kHZ frequency electron modulations observed by the Space Particle Correlator Experiment (SPACE) during beam operations on the Tethered Satellite System (TSS 1). The approach is to work in the frame of reference of the orbiter with the ambient plasma flowing past it. A 2-D (two position and two velocity components) treatment is chosen based on the geometry of the problem and computer limitations. The main emphasis of this work is to test that the free-flowing plasma is stable before including the effects of a beam.

Improvement of Cache Utilization and Parallel Efficiency of a Time-Dependent Maxwell Equation Solver

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Abstract

Performance improvement is achieved for a sequential Fortran time-dependent Maxwell equations solver through improved cache utilization and manual tuning of parallelization. This report describes the background of the project, the theory behind the improvement being achieved, the methodologies employed, and the experimental results obtained on the SGI Origin 2000.

Through loop fusion, loop interchange, loop index shift, and other loop transformations, we are able to enhance the cache locality in the program and to reduce the cache misses drastically. We also add several Power Fortran directives in the Fortran program to instruct the parallel compiler how to parallelize the code efficiently.

Experimental runs show that the execution time is reduced from 28 hours to about 3 hours on one Origin 2000 processor using loop transformations alone. The final version of our code runs efficiently on the Origin 2000 using up to 16 processors. In fact, our program uses less time than the corresponding MPI program when running on the SGI Origin 2000 using six processors, while the coding time involved is much shorter than the time used to develop the MPI code. Based on the experience learned during the summer, we believe that a high level parallel programming language such as the Power Fortran or High Performance Fortran is a viable and alternative way to parallelize many existing Maxwell equations solvers.

PREPARATORY WORK TOWARDS A COMPUTER SIMULATION OF ELECTRON BEAM OPERATIONS ON TSS 1

Michael J. Pangia
Associate Professor
Department of Geology & Physics
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Abstract

This work is the first stage towards a Particle-In-Cell simulation that will be used to explain the low kHZ frequency electron modulations observed by the Space Particle Correlator Experiment (SPACE) during beam operations on the Tethered Satellite System (TSS 1). The approach is to work in the frame of reference of the orbiter with the ambient plasma flowing past it. A 2-D (two position and two velocity components) treatment is chosen based on the geometry of the problem and computer limitations. The main emphasis of this work is to test that the free-flowing plasma is stable before including the effects of a beam.

MODELING OF IONOSPHERIC CONVECTION
FROM THE IMF AND SOLAR WIND DATA

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Abstract

It has been demonstrated in many studies that the large-scale, quasi-steady ionospheric convection at high latitudes is primarily controlled by the interplanetary magnetic field (IMF) and solar wind (SW) parameters. In this study we applied a linear regression analysis technique to the Defense Meteorological Satellite Program (DMSP) electrostatic potential database available at Phillips Laboratory/Geophysics (PL/GPS). We binned satellite data by every 1° of the corrected geomagnetic (invariant) latitude and 0.5 hour of magnetic local time (MLT). Then the regression analyses has been applied to the data in each bin in a similar way as it was done for construction of the IZMIRAN Electrodynamic Model (IZMEM) from ground magnetometer data. This allowed us to calibrate the IZMEM model against satellite data for a future attempt of constructing the DMSP electric potential model for prediction of the ionospheric convection over both the Northern and Southern polar regions solely from the IMF/SW parameters measured near the Earth's orbit.

AB INITIO QUANTUM CHEMICAL STUDIES OF NICKEL DITHIOLENE

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Abstract

Nickel dithiolene Ni(S$_2$C$_2$H$_2$)$_2$, was studied theoretically using *ab initio* quantum chemistry through the GAMESS quantum chemistry package. Only the neutral oxidation state was studied. It was found that the bonding pattern in this dye is complex and that an accurate description of the electronic state requires a multi-configurational-self-consistent-field (MCSCF) description. The electronic configuration of the nickel was found to be 8d in every important configuration. The electronic configurations, degree of approximation required, geometry, bonding structure and electronically excited states were studied, primarily using effective-core-potential basis sets in which the core electrons are not considered. The possibility of a distortion from the assumed D$_{2h}$ geometry associated with these low-lying states was examined. These results will make possible further studies of similar molecules, different oxidation states and other molecules with partially filed d orbitals.

PHASE TRANSITIONS IN PROBABILITY ESTIMATION AND CONSTRAINT SATISFACTION PROBLEMS

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Abstract

Experiments were conducted to identify phase transitions in two domains: estimation of multinomial probability distributions from observed relative frequencies, and determination of the consistency of database frequency tables. The database consistency problem required that the degree to which an instance is constrained (on the average) be represented in a unique way, as the superposition of two weighted undirected graphs.

Refined Reissner's Variational Solution in the Vicinity of Stress Singularities

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Abstract

The prediction of micro-mechanical damage initiation and growth in composite materials requires accurate stress and deformation analyses. Prior research at Wright Laboratories established the effectiveness of Reissner's variational method in determining the detailed stress fields in composite structures and for studying the micro-mechanical damage mechanisms. The present effort investigates the ability of this variational method to capture the details of the stress fields in the vicinity of bi-material cracks and corners in a single-fiber axisymmetric (concentric cylinder) model. The singular stress fields in these local regions drive the initiation and/or propagation of damage in the composite.

The results of this project are two-fold. First, several example problems varying the local geometry and boundary conditions are studied and the stress distributions obtained from asymptotic analyses are compared with the variational solutions. The variational solution is shown to accurately capture two of the three stress components within the meridian plane, namely the opening stress component and the shear stress component. The axial stress component, however, was significantly different from the asymptotic variation, possibly due to the influence of the boundary condition coincident with the singular point. This prompted modifications of the. variational solution procedure to accommodate the exact singular behavior. Modifications without a fundamental changes (stress function assumptions) to the variational formulation are investigated. A method, named the Interior Point Matching (IPM), which replaces a selected area around the singular point with asymptotic stress fields, ensures the continuity of the stress fields at an interior point, and satisfies the global equilibrium and boundary conditions with the embedded singular fields is developed. The Axisymmetric Damage Model (ADM) implementation of Wright Laboratories is enhanced to include local asymptotic solutions (the power of singularity and the angular variations), the software implementation of Interior Point Matching Method is completed and tested, and the example problems are solved to determine the extent of refinement and limitations of the modified solution. This report summarizes the results of the initial comparison and IPM development.

LOW DATA RATE MULTIMEDIA COMMUNICATION
USING WIRELESS LINKS

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Abstract

The report analyzes the variable length protocol medium resource controller(MRC) and a configurable protocol stack currently used for low data rate multi-media communications over wireless links at the Rome Air Force Lab, Rome, New York. The report also investigates the use of widely used TCP/IP protocols for such applications and discusses the methods of integrating the currently used proprietary protocols to the TCP/IP over wireless links.

WAVELET TRANSFORM TECHNIQUES FOR ISOLATION, DETECTION & CLASSIFICATION OF CONCEALED OBJECTS IN IMAGES

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ABSTRACT

The wavelet transform decomposes a signal or image into components on the basis of position as well as scale. Self-similarity across scales is an essential attribute of fractal properties of images. Also, a scale analysis of projections of objects provides feature vectors that are invariant to scaling and rotation. Both fractal analysis and scale analysis of projections have been found to possess good discriminatory properties in the isolation, detection and classification of concealed objects in images. The wavelet transform provides a natural framework for the implementation of these analyses. In fact, the only known wavelet matching techniques for optimum, matched filtered pattern recognition are for bandlimited wavelets. Accordingly, this research effort investigated the development of techniques for fast implementation of bandlimited wavelets and the development of a systems framework for scale analysis of discrete signals and images. The investigation has led to the development of perfect reconstruction circular convolution filter bank structures, construction of continuous-dilation, linear, scale-invariant, discrete-time self-similar signals and systems, and formulation of the scaling mixture problem for multichannel angle and doppler estimation for wideband signals.

COMPUTATION OF FREE SURFACE FLOWS WITH APPLICATIONS IN CAPILLARY PUMPED LOOPS, HEAT PIPES, AND JET IMPINGEMENT COOLING OF ELECTRONICS

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Department of Mechanical Engineering
University of South Florida

ABSTRACT

The numerical modeling and computation of free surface flows associated with the development of advanced thermal control devices for aircraft is the objective of the present investigation. Three important physical problems were studied. These are: (1) Prediction of free surface dynamics during vibration of a capillary pumped loop, (2) Prediction of liquid return flow in a helically-grooved heat pipe under high acceleration loading, and (3) Computation of heat transfer during liquid jet impingement on a horizontal surface. The numerical modeling was done by considering the governing transport equations and boundary conditions representing each physical problem and the computation was carried out using the computational fluid dynamics code FIDAP. Several interesting results were obtained. It was found that an extended meniscus is formed at the liquid-vapor interface when a capillary tube is subjected to vibration in the transverse direction. The computation of free surface flow in a helically grooved revolving heat pipe showed that a larger body force in the direction of the flow decreases the film thickness and increases the flow velocity providing the possibility of larger fluid transport through the groove and higher capillary limit. During jet impingement of a large Prandtl number fluid, the local heat transfer coefficient is maximum at the center of the disk and decreases gradually with radius as the flow moves downstream. The average heat transfer coefficient decreases with increase of disk thickness and increase of thermal conductivity of the disk material. A minimum temperature at the heat source can be realized for a disk thickness of about 1 mm. This maximum temperature can be reduced by increasing the thermal conductivity of the disk material. The temperature variation at the solid-fluid interface becomes larger with decrease of thermal conductivity of disk material and disk thickness.

OPTIMAL STRUCTURAL DESIGN OF MODULAR
COMPOSITE BARE BASE SHELTERS

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North Carolina AT State University

Abstract

This reports reflect the result of my research work at McClellan Air Logistics Center during summer 1997. The work was to optimally design a composite structural shelter for better operational characteristics compare to the current metallic bare base shelters and to reduce the airlift requirement. An analytical engineering design approach was implemented , and a composite along with a spreadsheet programming were developed for the analysis. The structural design included the weight of the materials, snow load, personnel load, wind gust of 110 mph, and a seismic zone of 3.

The optimal design concluded a 2"-thick web-stiffened core and a 0.05" thickness for the facing of the roof and wall sandwich panels. The floor panel, however, uses a 0.06" facing and similar core design. The webs are 0.0625" thick and placed in the core at 1.5" spacing. The material for facing is quasi-isotropic (0/90/45/-45) glass/epoxy laminate and polyurethane foam was used for the core. The material (45/-45) glass/epoxy was selected for the web stiffeners for its high shear resistance. The design of the beam and frame supports resulted in a 0.125"-thick rectangular pipe of 2"x2" dimension, using (0/90) graphite/epoxy composite. The connection beams along with all other interfacial components use an I-beam of 0.1" thickness and 2" depth of the same material as in beam supports.

The result of the weight analysis concludes a total weight of 12,947 lb. for the composite GPS shelter and 13,742 lb. for Composite ACH shelter. Composite GPS shelter weighs only 25% per volume of the weight of the current metallic MERWS shelters.

Further study is recommended for the stress analysis of the shelter under thermal, impact, and creep loading. Also, the manufacturing process of the shelter fabrication is required to be analyzed for the selection of the optimal processing method and feedbacking into design process.

ACCUMULATION OF STRONTIUM AND CALCIUM BY *DIDEMNUM CONCHYLIATUM*

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Abstract

The average concentration of strontium in the ascidian *D. conchyliatum* was found to be greater than 4000 ppm having a calcium concentration around 250,000 ppm. The average ratio of calcium to strontium in this didemnid was 58:1. This ratio was smaller than any of the other samples analyzed. Other samples analyzed included varieties of shellfish, corals, sponges, solitary and colonial tunicates, echinoderms, etc. Since the samples analyzed were from the same area, all were presumably exposed to the same concentrations of strontium and calcium, the same temperature effects, and the same overall environmental conditions. From all of the samples analyzed, the dry weight concentration of strontium in this didemnid was always greater than that found in almost all of the other samples.

The samples which showed accumulated strontium concentrations closest to *D. conchyliatum* were barnacles whose concentrations were in the upper 3000 ppm's and a coral whose concentration of strontium was greater than 8000 ppm. The calcium concentration of the barnacles, similar to the strontium concentration, was equally large; 440,000 ppm. The average ratio of calcium to strontium for the barnacle was almost double that for *D. conchyliatum*, 116:1. The calcium concentration in the coral was also quite large, 579,872 ppm. The ratio of calcium to strontium for the coral was 71:1 which is higher than that measured for the didemnid being examined.

THE EFFECTS OF INDIVIDUAL DIFFERENCES AND TEAM PROCESSES ON

TEAM MEMBER SCHEMA SIMILARITY AND TASK PERFORMANCE

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Abstract

The research reported here examined team member schema similarity, its predictors, and its relationship to team performance. This research has implications for applied Air Force problems such as UCAV (Unmanned Combat Air Vehicle) operation, transport command centers, information warfare, battlefield management, C^3I, and joint collaborative systems such as data walls, avatars, intelligent agents, and knowledge rooms.

One purpose of the present study was to test a portion of the Team Member Schema Similarity Model with modifications. It was hypothesized that team member individual differences would predict team process variables (team interaction process variables and group process variables) and team member schema similarity (TMSS). Team process variables and TMSS were hypothesized to predict team performance.

Data were collected in a laboratory setting. Forty-five two member teams attempted to solve a complex, ill-defined problem. Team members completed individual difference measures before working on the problem. After solving the problem, team members completed teamwork schema measures. TMSS was operationalized as schema agreement and schema accuracy. Team performance and team interaction processes were coded by raters. Preliminary results are reported that indicate some support for portions of the modified model. Future research and potential applications are discussed.

The Armstrong Laboratory Aviation Personality Survey (ALAPS): Norming and Cross-validation.

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Abstract

The Armstrong Laboratory Aviation Personality Survey (ALAPS) was developed to better psychologically assess aircrew. The 15 scales cover personality, psychopathology, and crew interaction styles. This work provides additional psychometric data in support of its use. A sample of over 1000 male and female student pilots provide thorough norming, additional evidence of reliability, and further construct validity.

MODELING HEAT FLUX THROUGH FABRICS EXPOSED TO A RADIANT SOURCE AND ANALYSIS OF HOT AIR BURNS

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Abstract

We studied previously measured heat flux data through a variety of fabrics of interest to the Air Force, including Nomex, PBI-Kevlar, and aluminized versions of the latter. The fabrics were irradiated with a quartz source at incident heat fluxes ranging from 2.2 to 4.0 cal/cm^2·s. Lumped heat capacity analysis of the data satisfactorily explained the shape of the experimental curves studied, but due to lack of data for optical and thermal properties, some of the parameters were found by curve-fitting. However, some of these compare favorably with those obtained from other studies. In another study, we also successfully simulated hot air skin burns using the BURNSIM model and other engineering data for heat transfer coefficients.

CLASSIFICATION OF HIGH RANGE RESOLUTION RADAR SIGNATURES
USING EVOLUTIONARY COMPUTATION

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Abstract

E-MORPH is multi-phase evolutionary learning system that evolves cooperative sets of feature detectors and combines their response using a simple linear classifier to form a complete pattern recognition system. The learning system evolves registered sets of primitive morphological detectors that directly measure normalized radar signatures. A special convolution kernel evolves simultaneously to extract information from the output of the primitive detectors to form real valued feature vectors. Starting with a population of trivial randomly generated detector sets, EMORPH uses a novel combination of three evolutionary learning techniques, genetic programming (GP), evolutionary programming (EP), and genetic algorithms (GA) to evolve increasingly complex detectors. The GP grows complex mathematical expressions that perform signal-to-signal transformations, EP optimizes convolution templates to process the results of these transformations, and the GA recombines sets of feature detectors to form orthogonal features. A simple linear Perceptron is trained to classify the resulting features forming a complete pattern recognition system. This report provides a brief description of E-MORPH and presents recognition results for the problem of classifying high range resolution radar signatures. This problem is challenging because the data sets exhibit a large within class variation and poor separation between classes. The specific data set used in this experiment consists of 100 signatures of six airborne targets drawn from a 10° x 10° (azimuth x elevation) view window. The best recognition system evolved using EMORPH accurately classified 98.7% of the training signatures (6 targets x 50 samples = 300 signatures) and 95.7% of the signatures in an independent test set (6 targets x 50 samples = 300 signatures). This result is based on a preliminary experiment that did not involve tuning EMORPH's control parameters for this specific problem. This suggests that even better performance can be achieved in future experiments. The techniques used in E-MORPH are not tied to radar signals. The approach is generic and readily transitions to many different problems in automatic target recognition.

INVESTIGATION OF FLUID MECHANICAL PHENOMENA RELATING TO AIR INJECTION BETWEEN THE SEGMENTS OF AN ARC HEATER

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Abstract

The details of the fluid mechanical behavior near the air injection slot in a segmented arc heater were computed. A vortex was found to exist at the downstream corner of the gap between segments. This vortex was shown to have the potential to entrain hot gas into the area between the segments. The presence of hot gas in this area increases the effective electrical conductivity making the arc heater much more susceptible to arcing between segments. The computations also suggest alternative air injection arrangements which could minimize the slot vortex strength and the vulnerability to arcing.

ANALYSIS OF TURBULENT MIXING IN THE STRATOSPHERE AND TROPOSPHERE

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Abstract

By analyzing the wavelet averages of thermal dissipation in the troposphere measured by the Argus platform, it is possible to determine regions where Kolmogorov's universal equilibrium hypotheses are valid. Not surprisingly, these regions of the flow exhibit spectra obeying the predicted $k^{-5/3}$ power law. In these regions, one also finds p^{th}-order structure functions that similarly obey the predicted $r^{p/3}$ power law. However, the nature and distribution of the regions of the flow wherein the dissipation is not constant remains unexplored, save that power law scalings are inapplicable in many cases. For all that it can accomplish, my treatment is relatively primitive. The underlying physical model is fairly simple and would benefit from further analysis such as multifractal distributions of scaling exponents. Also, more sophisticated signal processing would improve the quality of the data we are trying to analyze. For instance. the cold-wire probe response smooths the data to a resolution of 50 centimeters, though the data acquisition rate is capable of resolving scales down to 2 centimeters. It is a distinct possibility that the high frequency portion of the data can be recovered by deconvolving the raw data with an appropriate filter. This summer, I have been able to support Air Force calculations of the upper atmosphere by studying fundamental issues in turbulent mixing and signal processing.

AN IMPLEMENTATION OF THE MESSAGE PASSING INTERFACE ON RTEMS

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Abstract

The Message Passing Interface (MPI) is implemented with a real-time operating system (RTOS) called the Real-Time Executive for Multiprocessor Systems (RTEMS). The implementation is based on the shared memory driver based MPCI (Multiprocessor Communications Interface) layer of RTEMS and the public domain portable MPICH code. A RTEMS-specific new device is created for the MPICH implementation by replacing everything below and including the p4 layer with RTEMS-specific message passing code. The basic object used in RTEMS message passing is the message queue. Message queues are distributed in all N nodes with $N-1$ queues per node such that a sender node can deposit its message to a dedicated queue at the destination. Our MPI implementation should work for all MPI programs thus providing the complete MPI functionality.

NUMERICAL MODELING OF PHYSICAL CONSTRAINTS ON IN-SITU COSOLVENT FLUSHING AS A GROUNDWATER REMEDIAL OPTION FOR OPERABLE UNIT 1, HILL AIR FORCE BASE, UTAH

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ABSTRACT

In-situ cosolvent flushing has been suggested and tested as a possible method of remediation of the groundwater within Operable Unit 1 (OU1) at Hill Air Force Base, Utah. Small-scale tests were performed at the lab and the results of those results were used in numerical models to determine the constraints placed on scaling the treatment method up to the field-scale. Some of the physical limitations include the limited thickness of the saturated zone beneath OU1. The modeling package FEMWATER included as part of the Department of Defense Groundwater Modeling System was used. This package allows for the modeling of transport of solutes with variable densities. The modeling results suggest that the areal size of the field-scale system would be limited to approximately 0.09 hectares, requiring the need for over 30 such systems to treat the entire area of OU1.

A STUDY OF INTEGRATED AND INTELLIGENT
NETWORK MANAGEMENT

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Abstract

The development of an integrated and intelligent network management platform for the Information for the Warrior (IFTW) program was studied. Specifically, the issues in performance and resource management are outlined in this report. The performance trending technique for predicting *soft* network failures was investigated and the concept is described here. The feasibility of applying fuzzy rule-based system for hand-over between networks before any loss of communication was studied and the evaluation of the fuzzy system is reported. Also, a predictor-based architecture developed for a dynamic bandwidth management in an ATM environment is described.

ERRORS INHERENT IN
RECONSTRUCTION OF TARGETS FROM
MULTI-LOOK IMAGERY

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Abstract

Automated target recognition has benefited from cross-fertilization of development in related subdisciplines of image processing such as medical imaging. For example, the application of computerized tomography to synthetic aperture radar (SAR) imaging has produced 3-D reconstructions of ground targets on an experimental basis. In practice, by acquiring multiple views of a target (also called *multi-look imaging -- MLI*) that are subsequently merged mathematically, one can obtain reasonable approximations to higher-dimensional reconstructions of a target of interest. For example, multiple two-dimensional airborne images of ground objects can be merged via the Fourier transform (FT) to obtain one or more approximate three-dimensional object reconstructions. Additional methods of 3D model construction (e.g., from affine structure) present advantages of computational efficiency, but are sensitive to positioning errors.

In this study, an analysis of MLI is presented that applies to various scenarios of nadir, near-nadir, or off-nadir viewing with a small or large number of narrow- or wide-angle views. A model of imaging through cover describes the visibility of a given target under various viewing conditions. The model can be perturbed to obtain theoretical and simulated predictions of target reconstruction error due to (a) geometric projection error, (b) focal-plane quantization error and camera noise, (c) possible sensor platform errors, and (d) coverage of looks. An information-theoretic model is derived from the imaging model that can facilitate prediction of limiting sensor geometry and view redundancy under various imaging constraints (e.g., target and cover geometry, available range of look angles, etc.). Ongoing research emphasizes selection or design of target reconstruction algorithms based on estimated MLI data and systematic errors. Additional discussion concerns the use of physical models for facilitating inexpensive ($< \$150$) acquisition of image data for preliminary MLI algorithm testing.

Study notation is a subset of image algebra, a rigorous, concise, computationally complete notation that unifies linear and nonlinear mathematics in the image domain [Rit96]. Image algebra was developed at University of Florida over the past decade under the sponsorship of DARPA and the US Air Force, and has been implemented on numerous sequential workstations and parallel processors. Hence, our algorithms are rigorous and widely portable.

COMPUTATIONAL STUDIES OF HYDROGEN ABSTRACTION FROM HALOALKANES BY THE HYDROXYL RADICAL

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Abstract

One of the most efficient steps in the initial decomposition of HFCs under combustion conditions is proton abstraction by hydroxyl radicals. We have utilized *ab initio* quantum mechanics and Transition State Theory (TST) to calculate the temperature dependence of rate constants for the reactions, CH_xF_{4-x} (x=1 to 4) + OH → $CH_{x-1}F_{4-x}$ + H_2O. Rate constants calculated using HF/6-31G(d) frequencies and MP2/6-31G(d) structures to calculate reactant and transition state partition functions and the Hartree Fock imaginary frequency, ω_i, to compute the tunneling factors, Γ, yielded rate constants which were substantially greater than experiment. Adjustment of the energy barrier to effect agreement between experimental and calculated rate constants at 298 K gave Arrhenius plots that exhibitedmarkedly greater curvature than measured rate constants.

When the imaginary frequency and barrier height were calculated by fitting high level (G2) energies along the reaction path with a semi-empirical Eckart function, it was found that the calculated imaginary frequency is a factor of 2.5 lower than the HF/6-31G(d) value, indicating that the energy barrier is considerably broader than predicted by the latter frequency. When the new imaginary frequencies and barrier heights were used to calculate rate constants, it w as found that $k_{TST}<k(exp)$, but that lowering the barrier height (by an average of 4.7 kJ/mol for the four reactions) yields calculated rate constants which are in excellent agreement with experiment at all temperatures.

Computation of Nonlinear Viscous Panel Flutter Using a Fully-Implicit Aeroelastic Solver

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Abstract

The implicit time-accurate approach developed by Morton, Melville and Visbal (1997) for aeroelastic application is used here to study the flutter of a panel in the transonic regime. The phenomenon is modeled by coupling either Euler or Navier-Stokes equations for the fluid with the nonlinear plate deformation equations. The flow equations are solved at each time step by the Beam-Warming, alternate-direction, implicit scheme. The plate equation is solved by the Newmark-β method in time and a finite difference method in space. Lagging errors between the fluid and the structure are eliminated with Newton-like subiterations allowing the coupled system to achieve second-order temporal accuracy. The model is applied to compute the flutter stability boundary for simply supported and fixed panels. The stability boundary is computed for both Euler and viscous flow. The time response of the panel in stable and unstable regimes for various Mach numbers are presented. The effect of boundary layer in the production and suppression of the flutter is also investigated. The computed results are compared with available numerical results.

SMOOTHED SLIDING MODE CONTROL APPROACH FOR ADDRESSING ACTUATOR DEFLECTION AND DEFLECTION RATE SATURATION IN TAILESS AIRCRAFT CONTROL AND RECONFIGURABLE FLIGHT CONTROL

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Abstract

The following flight sliding mode control problems are considered: *tailess aircraft control, reconfigurable control of a traditional aircraft addressing actuator deflections and deflection rates saturation without damage identification, and control allocation and reconfiguration for damaged tailess aircraft.* Solving tailess aircraft control problem smoothed sliding mode virtual controllers are designed. A detailed investigation of properties of a smoothed sliding mode controller is accomplished. The sliding mode controller design is tailored to control allocation algorithm developed in the Wright Laboratory. The reconfigurable on-line sliding mode control strategy is developed for aircraft with "square " configuration to address actuator deflections and deflection rates saturation without damage identification . This strategy guarantees a high accuracy tracking performance of pilot's angular rates commands with given flying qualities before and after damage to an aircraft. The developed reconfigurable control strategy implies a smoothed sliding mode controller with a boundary layer reconfiguration. On-line explicit system (damage) identification is not required. Computer simulation sdemonstarted efficiency of the designed reconfigurable smoothed sliding mode controller.

Desorption and Aerobic Biodegradation of Dinitrotoluenes in Aged Soils

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Abstract

A study on the desorption kinetics and the biodegradation of dinitrotoluenes in aged soils was performed. Aged clayey soil contaminated with 2,4-DNT, 2,6-DNT, and 2,4,6-TNT was obtained from the Volunteer Army Ammunitions Plant in Chattanooga, Tennessee. The average extractable concentrations of 2,4-DNT, 2,6-DNT, and 2,4,6-TNT were 0.278 ($\pm$.004), 0.079 ($\pm$.002), and 0.297 ($\pm$.004) mg/g, respectively. The organic carbon content (f_{oc}) was 0.70 ($\pm$ 0.09)%. Using Tenax beads as an infinite sorptive sink, sequential desorption experiments were performed to measure the long-term desorption of DNT and TNT from the soil: 76% and 89% of the extractable nitrotoluenes were desorbed from the soil in one and three days, respectively. Biodegradation of the DNTs was measured in factorial soil slurry experiments. 2,4-DNT was readily available for degradation by the indigenous microorganisms. Complete mineralization, as evidenced by near stoichiometric NO_2^--N release, was achieved within 5 days. Addition of a known 2,4-DNT and 2,6-DNT degrading bacterial strain did not show any benefit. Little mineralization of 2,6-DNT was observed. Additional experiments were performed to evaluate the toxicity or inhibition of 2,6-DNT and TNT towards 2,6-DNT mineralization. The addition of either Tenax beads to reduce the aqueous concentration of 2,6-DNT and TNT or an induced 2,6-DNT degrader (JS922) to the soil slurries did not stimulate 2,6-DNT biodegradation. In separate experiments, it could not be confirmed that TNT at 25 mg/L negatively impacted 2,6-DNT mineralization by JS922. The above work indicates that rapid desorption of nitrotoluenes from the clayey soil tested makes compounds such as 2,4-DNT and 2,6-DNT readily available for biodegradation; that indigenous microorganisms can readily mineralize 2,4-DNT; while stimulation of 2,6-DNT mineralization appears difficult.

ATMOSPHERIC EFFECTS UPON SUB-ORBITAL BOOST GLIDE SPACEPLANE TRAJECTORIES

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Abstract

The Reusable Aero Space Vehicle (RASV) concept is considered in order to analyze the effects of various atmospheric conditions upon a mission to release a payload near to a polar, low earth orbit. After payload release, the spaceplane is intended to circumnavigate the globe and return to launch site by skipping off the atmosphere, while the payload nominally includes a small upper stage that boosts a satellite into a final orbit. In order to evaluate atmospheric effects, Monte Carlo atmospheric temperature, pressure, density, and winds (based on time of the year, recent solar activity, and vehicle geographic position and altitude) are applied to a baseline RASV mission. Results indicate that these around-the-world RASV trajectories are feasible under a broad range of atmospheric conditions. However, for a given set of flight controls, it is found that maximum vehicle altitude, aerodynamic heat rate, and skip amplitude, vary substantially with atmospheric perturbations.

Pharmacological Intervention to Increase the Time before Acceleration (+Gz) Induced Loss of Consciousness in Rats: Electroencephalographic Monitoring

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Abstract

Pilots flying missions in high performance aircraft are exposed to high acceleration forces which can cause gravity induced loss of consciousness(GLOC). Physical and physiological methods have been extensively studied and utilized to increase the time of consciousness by decreasing pooling of blood in the periphery of the body during high (+Gz). Little research has been done on pharmacological intervention to extend the time to GLOC, primarily due to the lack of a suitable animal model. This study on rats was designed to develop techniques to monitor the conscious state and to apply that information to the study of the consciousness extending effects of caffeine during high (+Gz). In rats accelerated to GLOC, the electroencephalographic (EEG) power spectrum within 1-40Hz was studied using fast Fourier transforms (FFTs). The power spectrum of 39-40Hz (gamma) appeared to be the most sensitive spectrum for predicting GLOC. Caffeine at 30 and 60mg/kg ip was again found to significantly extend the time before the occurrence of GLOC.

SIMPLE REAL-TIME TRACKING INDICATORS FOR A FREQUENCY FEEDBACK DEMODULATOR

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Abstract

Frequency feedback demodulators are discussed in general qualitative terms, and a recently proposed feedback demodulator is introduced. Then, two real-time algorithms are presented for assessing the tracking performance of the newly-proposed feedback demodulator. The first tracking indicator uses the fact that the output of the numerically controlled oscillator (NCO) should be highly correlated with a time-aligned version of the input signal when the loop is tracking well. The second tracking indicator employs the input and output signals of the bandpass filter (BPF) in the demodulator. The average power in each of these signals is approximated, and the tracking indicator makes its decision by comparing the ratio of these average powers to a user-specified threshold.

Destructive Objects

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Abstract

The use of object and object oriented technology has become one of the most widely used techniques in computer programming. This work examines the structure, development, and use of objects in order to examine the areas for potential run-time errors. This work defines a destructive object in relationship to its programming environment and considers how this type of object might be developed.

The problems that objects can cause in a system are neither well known nor are they simple to understand. This report takes a look at objects and their development in order to understand where undesirable properties of objects may come from. In addition to defining the destructive types of objects, this report looks at how two new approaches to using objects: language dependent and language independent, handle destructive properties. These approaches are considered for their ability to avoid certain destructive object behavior.

Suboptimal Control of Nonlinear Systems via Receding Horizon State Dependent Riccati Equations

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Abstract

The problem of rendering the origin an asymptotically stable equilibrium point of a nonlinear system while, at the same time, optimizing some measure of performance has been the object of much attention in the past few years. In contrast to the case of linear systems where several optimal synthesis techniques (such as $\mathcal{H}_\infty$, $\mathcal{H}_2$ and l^1) are well established, their nonlinear counterparts are just starting to emerge. Moreover, in most cases these tools lead to partial differential equations that are difficult to solve. In this research we developed a suboptimal regulator for nonlinear affine systems based upon the combination of receding horizon and state dependent Riccati equation techniques. Our main result shows that this controller is nearly optimal provided that a certain finite horizon problem can be solved on–line. Additional results include conditions guaranteeing closed loop stability even in cases where this fails, and an analysis of the suboptimality level of the proposed method.

PHOTOCONDUCTIVITY STUDIES OF THE POLYMER 6FPBO

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ABSTRACT

The polymer 6FPBO is the subject of an intense investigation by the Physics Group of the Polymer Branch of the Materials Laboratory at Wright Patterson AFB. Successful blue electroluminescent devices have been fabricated and the underlying physics is being pursued in continuing studies. This report summarizes a complementary study of the photoconductivity measurements on the electroluminescent devices and samples made from the starting materials.

An experimental system was put in place to acquire the photoconductivity spectra using equipment available in the Physics Group. The necessary software to control the experiment was developed. A methodology of normalizing the photoconductivity data was put in place, and 6FPBO devices were studied.

6FPBO samples produce a weak but measurable photoconductivity spectrum. The spectrum shows multiple peaks with two prominent features at about 340 and 405 nm. Preliminary investigations were made of the effect of bias voltage, probe beam intensity and the effect of chopping of the probe beam at different frequencies.

Difficulties with the normalization data preclude definitive assignment of the spectral shape. However, it is clear that the dependence of the photoconductivity on the probe intensity is linear – independent of uncertainties in normalization. Further, the dependence of the photoconductivity on the bias is supralinear for forward biased samples. (The electroluminescent devices may be considered to be Schottky diodes – by their structure and by their current-voltage characteristics). Two types of electroluminescent devices are routinely fabricated – monolayer devices using only 6FPBO and bilayer devices using 6FPBO with a PVK hole transport layer. In the case of monolayer devices, reverse bias caused an increase in photoconductivity with increasing reverse bias (although the total intensity was less than for the same forward bias). In the bilayer devices the photoconductivity was quenched with increasing bias. Chopping frequency studies were inconclusive.

HIGH VELOCITY PENETRATION OF LAYERED CONCRETE TARGETS WITH SMALL SCALE OGIVE-NOSE STEEL PROJECTILES

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Abstract

New Air Force designs for manned aircraft continue to follow the recent trend of internal weapon carriage for RCS considerations. Therefore, future penetrator designs must accommodate reduced mass and volume constraints. To meet these requirements the Air Force is focusing on smaller penetrators. A key technical issue associated with the small penetrators is high velocity impact phenomenolgy, especially into layered concrete targets. This report summarizes the results of a preliminary study to evaluate the effects of layering on the penetration of small scale projectiles. The results of the study indicate that layered targets experience a significantly larger amount of penetration than the corresponding monolithic target. A small scale testing program is recommended to investigate the problem further.

A VHDL MODEL SYNTHESIS APPLET IN TCL/TK

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Abstract

VHDL Model Synthesizer is a tool that enables a circuit designer to generate VHDL descriptions by customizing entity-architecture templates residing in the design database. Currently, the tool, written in Tcl/Tk, is distributed in the standard "*.tar.gz" format that must be downloaded and installed locally by each user. The goal of our work is to convert this tool into an applet in Tcl/Tk (called a *tclet*) residing on a web-server, to enable users to run it remotely in a web-browser (such as Netscape Navigator). The main benefit of this work is that only the master copy needs to be maintained, and the users are always guaranteed to have access to the latest version of the tool and the design database.

An effort is also underway to improve and port the VHDL-93 Design Description Browser tool, implemented using SWI-Prolog and Tcl/Tk, from the UNIX environment to the Windows-95/NT environment. This is being done by converting the TeX files (containing the parser code) into HTML documents, and rewriting the filter program and the Graphical User Interface in Java.

Grid Level Parallelization of an Implicit Solution of the 3D Navier-Stokes Equations

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Abstract

The objective of my summer faculty project was to work in collaboration with the computational scientists in the CFD Research Branch of Wright Laboratory to develop a parallel implementation of FDL3DI and related tools to support the parallel solution of the Navier-Stoke Equations for unsteady and vortical flows. My time was spent on two primary tasks: 1) Integrating the grid parallel FDL3DI, developed in 1996, with a simulation of the tail buffet phenomenon. 2) Develop a utility to split a single grid into overlapped subgrids to increase the exploitable parallelism for the grid parallel FDL3DI.

The tail buffet application, performs a numerical simulation of the impingement of a streamwise vortex on a plate. The initial grid system employed 4 grids with large size discrepencies. The grid system was manually subdivided to get 11 grids ranging to improve the processor load balance. Both configurations were executed in parallel on the IBM SP2 at the ASC MSRC system, using 4 and 11 processors respectively. The 11 processor run on the IBM SP2 is withing 17% of the run time of the four grid serial execution on the Cray C916 system.

In an effort to provide a convenient mechanism for decomposing a grid system into subgrids, I developed the GridSplit utility, which decomposes a single rectangular grid into overlapped subgrids. This tool was used to perform a preliminary scalability study of the grid parallel FDL3DI application for uniform flow.

A STUDY OF THE PARTICULATE EMISSIONS OF
A WELL-STIRRED REACTOR

Max B. Trueblood

Abstract

A well-stirred reactor system was constructed and a preliminary study of its particulate emissions was made using the University of Missouri-Rolla Mobile Aerosol Sampling system. The test matrix included hydrogen and hydrocarbon fuels where the fuel to air equivalence ratios were varied between lean stoichiometric and rich. Preliminary results indicate that particulate concentrations increased by several orders of magnitude as the equivalence ratio approached 1.0 compared to those for either lean or rich regimes. The size distributions were linear in shape between particle diameters of 10 and 250nm, with the peak at the smaller diameter. Results from this preliminary study were presented at the NASA Workshop on Aerosols, Cleveland Ohio, July 29-30 1997.

DISLOCATION DYNAMICS IN HETEROJUNCTION BIPOLAR TRANSISTOR UNDER CURRENT INDUCED THERMAL STRESS

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Abstract

The dislocation densities generated in the Heterojunction bipolar transistor (HBT) are caused by the current induced thermal stresses. A modified dislocation generation model is developed and then employed to calculate the increment of dislocation densities versus time in the HBT. Different stressing current densities and initial dislocation densities are used to verify the validity of this modified model. The results show that the increasing rate of dislocation density strongly depends on the stressing current density and lightly depends on the value of initial dislocation density.

SIMULATION OF A ROBUST LOCALLY OPTIMUM RECEIVER IN CORRELATED NOISE USING AUTOREGRESSIVE MODELING

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Abstract

This report presents the simulation of a robust *locally optimum* (LO) non-linear spread spectrum receiver. The signaling environment consists of the desired received signal in correlated interference and thermal noise. Autoregressive (AR) spectral modeling methods and a histogram approximation of the probability density function are employed. Preliminary results for transmission in the presence of *continuous wave* (CW) and *partial band* (PB) interference are presented and discussed. A comparison of this method to a similar nonlinear processing algorithm is performed. Preliminary results for the performance of a binary phase-shift keyed communications system indicate that applying AR modeling to the environment improves performance substantially, especially in the case of partial band interference.

TWO AXIS PNEUMATIC VORTEX CONTROL AT HIGH SPEED AND LOW ANGLE-OF-ATTACK

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Abstract

Forebody pneumatic vortex control has previously been demonstrated through full-scale flight test to be effective for directional control of aircraft at low Mach number and high angle-of-attack flight conditions. The objective of the present research was to investigate the suitability of two-axis (wing, and vertical tail) pneumatic vortex control on a current fighter-type aircraft at high Mach number and low angle-of-attack flight conditions. It was intended that the pneumatic effectors would both augment and replace the conventional aileron and rudder, and were used to control lateral/directional motions. The Lockheed F-16 XL was selected as the configuration to be studied, and evaluations were conducted on a high fidelity, nonlinear, six degree-of-freedom, non real-time simulation of this aircraft.

Evaluations consisting of a set of aggressive bank-to-bank maneuvers at various blowing coefficient levels, were conducted for pneumatic blowing as the primary control effectors with the conventional surfaces as augmenting effectors, and pneumatic blowing effectors only. A sample all pneumatic penetration strike mission was also investigated.

For the test cases studied, results demonstrate that by using pneumatic blowing at low blowing coefficient levels and with conventional effector augmentation, aileron and rudder activity and maximum deflections can be reduced. Progressively increasing the pneumatic control power demonstrated that at a realistic and attainable level of compressor bleed air, the aileron and rudder can be completely replaced by pneumatic devices yet allow the aircraft to complete aggressive bank-to-bank maneuvers. The simulated penetration strike mission test case demonstrated that successful completion of the mission is possible using only pneumatic lateral/directional effectors. Elevons were still used for pitch control since modeling did not permit the option of symmetrically blown ailerons.

A PROBABILISTIC FRAMEWORK FOR THE ANALYSIS
OF CORROSION DAMAGE IN AGING AIRCRAFT

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Abstract

Damage tolerance is the design philosophy used by the Air Force to manage the structural integrity of aircraft. The damage tolerance design philosophy assumes that cracks are always present in all aircraft structures, although they may be so small that they can not be detected. NonDestructive Inspection (NDI) techniques are utilized to measure the crack length. Analysis of crack growth is used to predict the number of fatigue cycles until the longest crack grows to half its critical length. This procedure is deterministic although there is significant uncertainty in the crack growth rate and in the detection of cracks.

The presence of corrosion in aging aircraft makes damage tolerance analysis more difficult. NDI procedures have been developed to detect cracks; detecting and quantifying corrosion is not well understood. The most common way to account for the effects of corrosion is to estimate the equivalent material thickness loss and then adjust the stress distribution accordingly. However, corrosion is nonuniform as verified by inspections of a number of corroded structural members from aircraft undergoing Programmed Depot Maintenance. Although some mild pitting corrosion might be approximated by equivalent material thickness loss, in the case of severe pitting and exfoliation unacceptable errors may be introduced by this approximation.

Sample mean and standard deviation of the crack growth constant were determined from regression analysis of crack growth data for several aluminum alloys and corrosion conditions. The data were collected during US Air Force sponsored round robin testing conducted at four different laboratories. Variability in the crack growth was modeled by variation in the Paris crack growth constant. The crack growth rate was then numerically integrated to estimate the mean and standard deviation of the crack length. The reliability, defined as the probability that the crack length exceeds the critical crack length, was calculated as a function of loading cycles. Results show that although the crack growth rates for corroded material falls within the scatter bands from traditional damage tolerance analysis, corrosion has a very distinctive effect on the reliability function. Reliability analysis is proposed as a suitable design tool for damage tolerance of aircraft structures with hidden corrosion.

TELEROBOTIC CONTROL ARCHITECTURE INCLUDING FORCE-REFLECTING TELEOPERATION

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Abstract

This report summarizes the author's work in the *AFOSR* 1997 Summer Faculty Research Program, based in the Human Sensory Feedback (*HSF*) Laboratory of Armstrong Laboratory, located at Wright-Patterson *AFB*. A powerful and general control architecture is presented for real-time, sensor-based, rate-based, shared control of general telerobotic systems including force-reflecting hand controllers (*FRHCs*). Implementation is discussed to specific *Freflex/Merlin* hardware in the *HSF* Lab. A *Matlab* simulation of *Freflex/Merlin* teleoperation under joint and Cartesian pose and rate control was developed and delivered to the *HSF* Lab. This marks the first time the *Freflex* exoskeleton has been used to control the *Merlin* slave manipulator. A major focus is force-reflecting teleoperation to increase telepresence in remote operations. This architecture has been partially implemented in hardware and the work is progressing. Additional accomplishments are the novel Naturally-Transitioning Rate-to-Force Controller (*NTRFC*) and mathematical modeling for the planar version of the novel cable-suspended haptic interface.

SIMULATION OF A ROBUST
LOCALLY OPTIMUM RECEIVER IN
CORRELATED NOISE
USING AUTOREGRESSIVE
MODELING

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Abstract

This report presents the simulation of a robust *locally optimum* (LO) non-linear spread spectrum receiver. The signaling environment consists of the desired received signal in correlated interference and thermal noise. Autoregressive (AR) spectral modeling methods and a histogram approximation of the probability density function are employed. Preliminary results for transmission in the presence of *continuous wave* (CW) and *partial band* (PB) interference are presented and discussed. A comparison of this method to a similar nonlinear processing algorithm is performed. Preliminary results for the performance of a binary phase-shift keyed communications system indicate that applying AR modeling to the environment improves performance substantially, especially in the case of partial band interference.

AN PSYCHOMETRIC EXAMINATION OF THE MULTIDIMENSIONAL WORK ETHIC PROFILE AMONG AIR FORCE ENLISTED PERSONNEL

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Abstract

The present study examines the psychometric properties of the Multidimensional Work Ethic Profile

(MWEP) developed by Michael Miller and David Woehr (Woehr & Miller, 1997, Miller and Woehr, 1997) with Air

Force enlisted personnel. The MWEP is a multidimensional measure of work ethic based on previous literature and

research focusing on work ethic and job performance. Originally developed based on a sample of university

students, the MWEP has demonstrated good psychometric characteristics including reliability and validity. The

MWEP has been suggested as a potentially valuable screening tool with Air Force enlisted personnel. The purpose

of the present study was to provide a preliminary evaluation of the measure among Air Force enlisted personnel.

Results indicate that the measure does demonstrate similar psychometric characteristics among Air Force enlisted

personnel as with the original developmental sample. The MWEP provides reliable and valid measures of multiple

dimensions underlying the work ethic construct. These results indicate that the MWEP may be a useful screening

tool for Air Force Personnel.

AN EXPERIMENTAL AND COMPUTATIONAL ANALYSIS OF THE UNSTEADY BLADE ROW POTENTIAL INTERACTION IN A TRANSONIC COMPRESSION STAGE

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Abstract

A computational and experimental investigation is performed to investigate the unsteady upstream traveling forcing function from a high speed, highly loaded compression rotor. The IGV unsteady surface pressures are experimentally measured for a near-stall transonic operating point to determine the forcing function. The data is analyzed in both the time and frequency domain based on the blade pass frequency. The experimental configuration is computationally modeled with a nonlinear unsteady viscous vane/blade interaction 2D code for comparisons with the experimental data in both the time and frequency domain.

Significant upstream traveling pressure effects were both measured and predicted. A detached bow shock is caused by the increased back pressure consistent with a near stall operating point. The bow shock is shown to impact the IGV blades. Its strongest effect is at the trailing edge of the IGV's with a 3.4 psia fluctuation. The nonlinear viscous unsteady vane/blade interaction computational analysis showed excellent agreement with the experimental results in both the time and frequency domain. Significant higher harmonic content was evident near the trailing edge of the IGV's. This is important, in light of recent trends toward use of linearized Euler and Navier-Stokes models for turbomachinery designs. The results of this research indicate the importance of higher harmonics, therefore extreme caution should be taken when designing transonic compression stages with linearized methods.

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THERMODYNAMIC STABILITY AND OXIDATION BEHAVIOR OF REFRACTORY (Hf, Ta, Zr) CARBIDE/BORIDE COMPOSITES FOR ULTRA HIGH TEMPERATURE APPLICATIONS

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ABSTRACT

The multicomponent thermodynamic stability diagrams for the complex (Hf, Ta, Zr, Si)-C(B)-O, Hf-Ta-C(B)-O and Zr-Si-C(B)-O systems were generated using the proposed linear inequality method, where the stability area of compound is the solution of a set of linear inequalities which is directly obtained from the free energy changes of general chemical reactions. The thermodynamic relationships in the oxide scale and the complicated interfacial reactions in the high temperature oxidation of these systems were analyzed using the generated diagrams. The possible phases formed on the HfC-TaC, HfB_2-TaC, HfB_2-TaB_2, HfC-TaB_2, ZrB_2-SiC, ZrC-SiC composites at high temperatures were predicted. The interactions between oxidation byproducts (CO, CO_2, B_2O_3 gases), carbides (or borides) and porous oxides were analyzed. The possible kinetic rate-controlling processes were discussed based on the considerations of outward and inward gas diffusion model and outward and inward ionic diffusion model. Finally, attempts to improve the oxidation resistance of refractory carbide/boride composites will be discussed.

A PROCESS ENGINEERING APPROACH TO CONTINUOUS COMMAND AND CONTROL ON SECURITY-AWARE COMPUTER NETWORK

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Abstract

It is of strategic importance to move command and control (C^2) from schedule-driven cyclic operations to situation-driven continuous operations so that C^2 can respond to new campaign objectives and situation updates in a timely fashion. The responsiveness of C^2 requires the integration of currently loosely connected C^2 operations into a coherent infrastructure and a continuous workflow that are supported by a security-aware computer network. The objective of my summer work at the Information Institute of the U. S. Air Force's Rome Laboratory is to investigate the feasibility of a process engineering approach to continuous command and control as well as network security management. The investigation focuses on the development of a process model for C^2 operations and a process model for network security management, based on the dynamic process modeling schema.

The process model for C^2 operations consists of a four-level abstraction hierarchy that supports the integration of C^2 operations across different levels (i.e., objectives, targets, tasks, actions, and events), different stages at each level (i.e., planning, scheduling, execution, monitoring, assessment, and replanning), and different functional areas at each level and in each stage (i.e., force application, force enhancement, and force support). The process model for network security management considers network intrusive behaviors as anomalies or deviations from the security specification and profiles of a computer network. This process model will provide a coherent infrastructure to integrate existing security management techniques. It will also guide future work concerning how existing techniques should be advanced, how different techniques should be integrated, what security policies should be specified, what network activities should be visualized for security management, what should constitute a rapid prototyping environment of security management system, and so on.

IMPROVED AIRCRAFT ROLL MANEUVER PERFORMANCE USING SMART DEFORMABLE WINGS

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Abstract

In the research during the Summer Faculty Research Program, the aspects of modeling and control design methodology for improving roll maneuver performance in aircrafts (for achieving a desired roll rate) by deforming a flexible wing with piezoelectric actuation and sensing are studied. An integrated finite element model of a laminated composite plate embedded with smart piezo actuators and sensors subject to aerodynamic loading giving rise to a steady roll rate is developed. The resulting model in the generalized coordinates which has nonsymmetric aerodynamic damping matrix and a nonsymmetric stiffness matrix (due to aerodynamic stiffness) is then transformed to real but nonorthogonal modal coordinates and a reduced order model is developed. A new control design algorithm based on 'Reciprocal State Space' framework is then developed to achieve the desired roll rate and to simultaneously suppress the flexible mode vibrations. The research carried out clearly delineates the relationship and interaction between the structural, aerodynamic and piezo actuation based control subsystems and underscores the importance, potential and the vast scope of the proposed integrated approach to improve aircraft maneuver performance.

LOGISTICS ASSET MANAGEMENT: MODELS AND SIMULATIONS

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Abstract

The end of the Cold War brought many changes to the U.S. Armed Forces. Today's Air Force must work not only harder than ever before but also smarter and more efficiently. With limited resources, the Air Force of the 1990s and beyond continues to face the increasing challenges of maintaining aging weapons systems while bringing in new weapons systems. In this light, logistics planning and simulation tools are expected to increase productivity and decrease waste. The Oklahoma City Air Logistics Center (OC-ALC) located at Tinker Air Force Base, Oklahoma, is one of five ALCs. Along with San Antonio ALC located at Kelly AFB, Texas, the two ALCs service majority of U.S. Air Force aircraft. Logistics modeling and simulation tools are needed to assist management in decision making at OC-ALC. To address this need, several logistics planning and simulation models including RAMES, CREST, UNIRAM, LCOM, and others were evaluated for their scientific merit and organizational need. Deficiencies in modeling techniques have been carefully studied. Logistics Composite Model (LCOM) is recommended as the optimal choice for OC-ALC based on its versatility, scope, and development. A preliminary study has been completed on implementing LCOM and its role as the forecasting tool at OC-ALC. An order of magnitude analysis determines that adopting LCOM is expected to save $40-60 million for OC-ALC.

MODES OF HUMAN HEAD/NECK RESPONSE
TO VERTICAL IMPACT

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Abstract

Helmet-mounted systems, such as night vision goggles and helmet-mounted displays, have come into increased demand in recent years. Though these devices enhance the pilot's performance, they may also increase the chance of neck injury during ejection. The helmet-mounted systems change the helmet's mass properties such as weight, moment of inertia, and center of gravity location, which may alter the head/neck response and possibly change the pattern of neck loading. To define the specifications or criteria for allowable head mounted mass and center of gravity location that is safe for the crew members, identification of the head/neck responses and the factors influencing those responses is necessary. The objectives of this study were to identify the modes of head/neck response to vertical impacts, to determine and assess the parameters influencing head/neck response and to determine a method of predicting mode of head/neck response for a given subject under given conditions. The data used in this study came from five test cells of the Female Impact Program (FIP) study performed by the USAF Armstrong Laboratory on their Vertical Deceleration Tower (VDT) facility. The subjects were exposed to acceleration levels comparable to those experienced in the catapult phase of ACES II ejections. The peak acceleration level for the tests used in this study was 10 G. Each of the subjects wore the same type of helmet. However, the weight and inertial properties of the helmet were varied to simulate those of current helmet-mounted systems.

Five modes of head/neck response for vertical impact were identified and characterized. Modes A and B represent forward neck and head rotation. Modes C and D represent forward neck rotation and rearward head rotation. Mode E of head/neck response represent no significant neck or head rotation. Two experimental parameters, namely, initial linear x-acceleration of the head at the mouthpiece and head pitch as measured by the motion of the mouthpiece LED with respect to the shoulder LED, were found to be sufficient to uniquely define the mode of head/neck response. Three categories of parameters have been identified and suggested to be the determining factors in a given subject's mode of response for a given condition. The categories include initial position, anthropometry, and other factors such as helmet, weight, helmet center of gravity location and impact acceleration level.

A STUDY OF LASER INDUCED PLASMA DAMAGE OF THIN METAL FOILS

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Abstract

Various metal foils were subjected to repeated exposure to laser energy and the plasma discharge and damage associated with the exposure was studied. Two types of aluminum foils and gold foil were exposed to a low power, 1061 nm Nd:Glass laser. The foils underwent unconfined ablation and the plasma intensity was recorded using a Silicon PIN detector. The recorded intensity varies directly with the type and surface of the material. After initial exposure, the intensity varied due to material impurities and surface finish.

EIKONES - AN OBJECT-ORIENTED LANGUAGE FOR IMAGE ANALYSIS AND PROCESSING

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Abstract

This paper presents an object oriented language, called EIKONES, for efficient and flexible image processing. The EIKONES language provides to the user flexibility and friendliness for image processing which are not available in other image processing tools. The basic idea behind EIKONES is the consideration of the image processing algorithms as objects and the appropriate development of a formal grammar for its actual implementation. Results are provided by using the EIKONES language implemented by C++ for a PC environment. The implementation of EIKONES Language has a current size of 3K lines code.

IDENTIFICATION AND QUANTITATION OF N-METHYL-1-(3,4-METHYLENEDIOXYPHENYL)-2- BUTANAMINE (MBDB) TOGETHER WITH ITS METABOLITE, 3,4-METHY-LENEDIOXYPHENYL-2-BUTANAMINE (BDB) IN URINE.

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ABSTRACT

N-methyl -1- (3,4 -methylenedioxyphenyl) 1-2-butanamine (MBDB) is the α-ethyl homologue of 3,4 -methylenedioxymethamphetamine(MDMA), commonly known as "Ecstasy." This work accomplishes the concurrent identification and quantitation of MBDB and its more potent metabolite, 1-(3,4-methylenedioxyphenyl) -2- butanamine(BDB) using gas chromatography- mass spectrometry (GC/MS). Solid phase extraction was found to be preferable to the popular liquid-liquid extraction method. The use of 1% HCl in methanol, which is normally added after extraction to decrease the volatility of amphetamine bases, was shown to increase the overall yield of MBDB and BDB. Derivatization of **MBDB** and **BDB** with heptafluorobutyric anhydride (HFBA) permitted identification and quantitation by GC/MS in the selected ion monitoring (SIM) mode. Fragments used were m/z 176, 210, and 268 for MBDB and m/z 135, 176, and 254 for BDB. Using d_5- MDMA as an internal standard, the linear range of the method was demonstrated between 10 and 2000 ng/mL.

A WAY TO CONDENSE THE TIME CONSUMING
PROCEDURE OF COGNITIVE TASK ANALYSIS

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Abstract

Cognitive task analysis is a complex, time depleting process. Cognitive task analysis (CTA) is a group of processes that are aimed to designate the knowledge, skills and organization of fulfilling a certain task. This report will summarize the work that I contributed to the ongoing, substantial cognitive task analysis project named DNA (Decompose, Network, Assess). A brief description of the DNA project will be given, as well as short explanations of literature research conducted and specific tasks in which I participated with a goal of furthering the DNA project.

CONTRIBUTION OF A SCENE PROJECTOR'S NON-UNIFORMITY TO A TEST ARTICLE'S OUTPUT IMAGE NON-UNIFORMITY

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ABSTRACT

A mathematical model of the contribution of the non-uniformity of a projector array to the non-uniformity of a test article's output image was developed. Using this model the maximum theoretical limit for the output image non-uniformity was determined. The realistic situations likely to be encountered during simulation testing were all found to be significantly below the theoretical maximum. The output image non-uniformity is dependent upon the non-uniformity of the projector array, as well as a weighting factor which results from the contribution of the different emitters upon individual detector elements. It is through this weighting factor that parameters such as the sampling ratio, the fill factor of the detector array, the optical blur of the emitters, and the alignment of the emitters with respect to the detectors influence the non-uniformity. A computer program has been written to numerically approximate the weighting factor for a user defined set of parameters.

FREQUENCY STABILIZATION OF AN Nd:YAG LASER

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Abstract

A frequency stabilization technique based on locking to the reflection mode of a high finesse cavity is described. The experimental apparatus for locking two lasers to adjacent modes of the cavity was designed and built based on this technique. A feedback control loop was assembled, including the design and construction of a highly variable servo with maximum bandwidth and desirable response at unity gain. The noise characteristics of the control loop are investigated, and the most significant component is found to be the discriminator. The discriminator error signal was observed and showed superior performance and low noise density. The discriminator constant was measured to be 4.100V/MHz, and the actuator constant was found to be 4.517 MHz/V. This work is part of a project to develop a high powered laser with narrow linewidth for use in spectroscopy and the development of optical time standards.

VISUALIZATION AND TWO-COLOR DIGITAL PIV MEASUREMENTS IN CIRCULAR AND SQUARE COAXIAL NOZZLES

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Dr. Dimitris Nikitopoulos
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Abstract

The results of Laser-Sheet Visualizations carried out in cold air flows generated by coaxial, non-circualar jets are presented. Various geometry combinations employing square, triangular, lobed, and circular nozzles have been examined. The flows are at modestly high Reynolds numbers between 14,000 and 29,000. The inner-to-outer jet velocity ratio λ^{-1} varies from 0.15 to 0.22 to 0.3. The visualizations were carried out on vetical planes and cross-stream (horizontal) planes, using a pulsed laser sheet and seeding the air flow with $TiCl_4$. Images were recorded with a high-resolution (3000x2000 pixels) CCD array camera. Time-averaged visualizations were used to qualitatively assess shear layer growth in the near field of the jets. Comparisons between the circular and non-circular jet configurations indicated considerable mixing enhancement when non-circular nozzles were used. The visualizations revealed interesting interactions between the inner and outer non-circular shear layers in the near field. The interaction regions of inner and outer jet shear layers are characterized by more "wispy," stretched-out structures, or bulges in the shear layer, as seen in the cross-stream planes, than those observed in the regions where such interaction is absent. The presence of large-scale periodic structures is evident near the origin of the shear layers, although not as clear as in lower Reynolds number flows. Internal unmixed regions diminished with decreasing velocity ratio and at the low velocity ratios strong evidence of unsteady re-circulation and back-flow was observed at the end of the core of the inner jet manifested by oscillating mushroom vortex pairs. Two-color digital PIV measurements were made on the centerlplane of the circular and square jets at a Reynolds Number of 19000 for the coflow air and a jet velocity ratio of 0.3. A time increment of $20\mu sec$ was used between the green and red laser pulse to provide sufficient resolution of the velocity vectors. Scans across the square jet were made with the DPIV system. Aluminum oxide was used as the seeding particles for the DPIV images.

EFFECTS OF BRAIN TEMPERATURE ON FATIGUE IN RATS DUE TO MAXIMAL EXERCISE AND 2.07 GHz MICROWAVE RADIATION

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Abstract

In previous experiments, it has been observed that fatigue in rats may be linked to hypothalamic temperatures (T_{hyp}) and that exercising rats become exhausted once the T_{hyp} has reached approximately 40.7-41.5°C. We attempted to prove the validity of this observation by subjecting a group of rats to two separate treatments, a microwave (MW) and a sham exposure, each followed by a run to exhaustion. Hypothalamic and rectal temperatures (T_{rec}) were measured continuously during their run. Each rat underwent both the microwave and the sham treatments. For the microwave treatment, the rat was placed in a Styrofoam restrainer and its T_{hyp} was heated with MW radiation up to 41.5°C. During the sham treatment, the rat was also restrained, but not exposed to any microwave radiation. There were significant differences in both pre-run T_{hyp} and T_{rec} between sham and microwave rats. However, there was no significant difference between the two treatments for either the peak T_{rec} or T_{hyp}. Although there existed no significant difference between the mean time to exhaustion of the sham and microwave groups, there was a significant difference between the heating rate and weight loss of the two groups. Because there was no significant difference between the mean peak T_{hyp}, we conclude that there exists a critical brain temperature which limits the ability to perform exercise.

A Study of Defects and Dark Current Mechanisms
in Triple-Junction GaInP$_2$/GaAs/Ge Photovoltaic Cells

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Abstract

Triple-junction GaInP$_2$/GaAs/Ge n$^+$/p photovoltaic cells, monolithically grown by metal-organic vapor deposition, were studied by optical and electronic microscopy to look for defects responsible for dark currents in the cell. Physical abnormalities introduced during the manufacturing process indicated the need for more careful handling of the cells. Forward-bias dark current measurements were consistent with recombination theory at the cell's maximum power point. Two, "2$^1/_2$"-junction GaInP$_2$/GaAs/Ge, single-junction GaAs/Ge and single-junction GaAs/GaAs cells also showed similar dark current mechanisms.

SYNTHESIS OF A NOVEL SECOND ORDER NONLINEAR OPTICAL POLYMER

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ABSTRACT

Synthesis of second order nonlinear optical (NLO) polymers represents an exciting field with the resulting chromophore containing materials being used in such devices as frequency doublers or electro-optical computers. In this research, a novel NLO monomer is developed by incorporating a fluorene molecule in its backbone with amine and benzothiazole end groups that act as electron donating and withdrawing groups, respectively. Ethyl chains are attached to the C-9 carbon on the fluorene backbone to aid in the polymer's overall solubility. Different reaction conditions for polymerization are also examined.

AN EXPERIMENTAL AND COMPUTATIONAL ANALYSIS OF THE UNSTEADY BLADE ROW POTENTIAL INTERACTION IN A TRANSONIC COMPRESSION STAGE

Danielle E. Brown
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Abstract

A computational and experimental investigation is performed to investigate the unsteady upstream traveling forcing function from a high speed, highly loaded compression rotor. The IGV unsteady surface pressures are experimentally measured for a near-stall transonic operating point to determine the forcing function. The data is analyzed in both the time and frequency domain based on the blade pass frequency. The experimental configuration is computationally modeled with a nonlinear unsteady viscous vane/blade interaction 2D code for comparisons with the experimental data in both the time and frequency domain.

Significant upstream traveling pressure effects were both measured and predicted. A detached bow shock is caused by the increased back pressure consistent with a near stall operating point. The bow shock is shown to impact the IGV blades. Its strongest effect is at the trailing edge of the IGV's with a 3.4 psia fluctuation. The nonlinear viscous unsteady vane/blade interaction computational analysis showed excellent agreement with the experimental results in both the time and frequency domain. Significant higher harmonic content was evident near the trailing edge of the IGV's. This is important, in light of recent trends toward use of linearized Euler and Navier-Stokes models for turbomachinery designs. The results of this research indicate the importance of higher harmonics, therefore extreme caution should be taken when designing transonic compression stages with linearized methods.

ASSESSMENT OF COAGULANT AGENTS ON THE REDUCTION OF AQUEOUS FILM FORMING FOAM (AFFF) IN WASTEWATER

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ABSTRACT

Aqueous film-forming foam (AFFF) concentrate is used by the Air Force (AF) to fight aviation fuel fires. Accidental spills of this material are collected in waste basins and are then transferred to wastewater treatment plants (WWTPs). The characteristics of the AFFF which make the compound a highly effective fire suppression system also make it toxic to aquatic animals and troublesome to wastewater treatment facilities due to its high BOD level and foam stabilizers. The use of coagulant agents to minimize the formation of foam was the central focus of this study. A detergent-Alconox, mineral oil, polymer - Chemlink, and defoamers (Calgon 926 and 935; Nalco 2508-Plus) were used to treat a 1L sample of 300 mg/kg concentration of 6% AFFF. The defoamer 2508-Plus by Nalco was found to be the best coagulant. The 300 mg/kg concentration of 6% AFFF, once treated with the Nalco product and after additional agitation, did not re-foam. The optimum dosage for 300 mg/kg concentration of 6% AFFF is 1.75 mls or 35 mg/kg of 2% Nalco 2508-Plus. The treatment cost would be $0.01 per 1.75 mls. On a larger scale of about 40,000 gal 300 mg/kg of 6% AFFF the treatment costs would be @ $1778.15. Continued study, however, to identify the most effective coagulant with the least expensive dose of chemicals will provide a more cost-effective method for the treatment of AFFF in wastewater.

THE EFFECTS OF INDIVIDUAL DIFFERENCES AND TEAM PROCESSES ON

TEAM MEMBER SCHEMA SIMILARITY AND TASK PERFORMANCE

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Abstract

The research reported here examined team member schema similarity, its predictors, and its relationship to team performance. This research has implications for applied Air Force problems such as UCAV (Unmanned Combat Air Vehicle) operation, transport command centers, information warfare, battlefield management, C^3I, and joint collaborative systems such as data walls, avatars, intelligent agents, and knowledge rooms.

One purpose of the present study was to test a portion of the Team Member Schema Similarity Model with modifications. It was hypothesized that team member individual differences would predict team process variables (team interaction process variables and group process variables) and team member schema similarity (TMSS). Team process variables and TMSS were hypothesized to predict team performance.

Data were collected in a laboratory setting. Forty-five two member teams attempted to solve a complex, ill-defined problem. Team members completed individual difference measures before working on the problem. After solving the problem, team members completed teamwork schema measures. TMSS was operationalized as schema agreement and schema accuracy. Team performance and team interaction processes were coded by raters. Preliminary results are reported that indicate some support for portions of the modified model. Future research and potential applications are discussed.

THE SYNTHESIS OF A PROTECTED CARBOXYLIC ACID DERIVATIVE FOR ATTACHMENT TO C_{60}

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Abstract

Three steps (Scheme 1) in a literature synthesis of a carboxylated C_{60} derivative were completed. These three steps yielded the precursor protected carboxylic acid derivative which will be added to the C_{60} and subsequently deprotected (Scheme 2) for further study as an optical limiting chromaphore. The first step involves a condensation reaction between a hydrazide and an aldehyde to form a hydrazone. This product which contains a carboxylic acid is chlorinated to the acid chloride. In the final step, two reactions occur in the same pot. The acid chloride is protected using an ester linkage and the hydrazone is deprotected forming a diazide. The synthesis sounds straight-forward but proved to be troublesome.

THE CHARACTERIZATION OF HIGH PERFORMANCE QUANTUM WELL INFRARED PHOTODETECTORS FOR LOW BACKGROUND OPERATION

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University of Florida

Abstract

The design and characterization of a number of quantum well infrared photodetectors (QWIPs) was carried out. The devices studied over the course of the summer program include: (1) a compressively strained p-type superlattice (SL-) QWIP with a spectral responsivity peak at 19.2 μm with a corresponding cut-off wavelength of greater than 20 μm, (2) a truly voltage tunable unstrained SL-QWIP with a spectral responsivity peak at either 9.2 or 6.5 μm and (3) an InP based QWIP with tensile strain (TS-) layers that responds at 4.4 μm and 6.5 μm as a function of applied bias. All of these devices were grown by molecular beam epitaxy on GaAs, except for the InP based TS-QWIP. The exact performance in terms of dark current, background photocurrent, noise, responsivity, detectivity and quantum efficiency gain product will be discussed in this report.

PERCEPTION OF VELOCITY AS A FUNCTION OF THE OCULOMOTOR STATE OF THE EYES

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ABSTRACT

Two studies investigated velocity perception as a function of the oculomotor state of the eyes (vergence and accommodation). In the first experiment, images of moving simulator terrain were viewed on collimated and real (non-collimated) displays. The collimated display induced little to no vergence and the real display, at close viewing distances, induced a large amount of vergence. When the images in the collimated and the real displays were set at equal velocities, the collimated image appeared faster than the real image. Thus the velocity of the real image had to be increased in order for the two images to be perceived as identical in velocity. A pilot study is currently underway to identify any problems associated with this study.

In the second experiment, a moving texture pattern was viewed on flat surface screens placed at varying distances from the observer. The primary focus of this experiment was to examine how changes in the oculomotor state of the eyes effect the perception of velocity. The far display (viewed at 5.5 m from the observer) induced less ocular vergence and appeared faster than either of the near targets (viewed at 1.2 m or .5 m from the observer). Thus the velocity of both near targets had to be increased in order for the images to be perceived as identical in velocity. Data collection has been completed for the multiple-linear and multiple-radial motion, and is currently being collected for the multiple-circular motion.

VISION ALGORITHMS FOR MILITARY IMAGE PROCESSING

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ABSTRACT

Two vision-inspired algorithms were written to decode the wavelength and intensity maps of images. One uses a two-layer detector approach, while the other attempts to simulate a two-layer detector using a checkerboard configuration. To test these innovative detector concepts, an algorithm had to initially encode the wavelength and intensity maps of the images. Experimental results indicate that the vision algorithm, which uses two layers of detectors, would decode the simulated images exactly. On the other hand, the checkerboard pattern vision algorithm, which uses one layer of detectors, showed only minimal degradation with the test images. However, the checkerboard layout may have unique benefits such as a built-in edge detection system.

INTRODUCTION

The vision algorithms use two image matrices to encode an image. The first matrix is a wavelength map, where the pixels are representing the colors present in the image. The second matrix is an intensity map, representing the intensity of all the objects in the viewing area. In the intensity map, all of the pixels are represented by a grayscale, where 0 represents the darkest intensity, and 255 represents the brightest intensity.

The first step is to generate the Photon Absorption Curves corresponding to both medium and large cone detectors in the human eye. Using Matlab, a Gaussian curve is generated using a vector length of 401 and a variance of 40. The curve is then normalized to have a maximum peak of one. A second Gaussian curve is then generated, by taking a copy of the first curve and shifting it to the right by 15 units. The two Gaussian curves are then overlapped together, forming both a medium and large cone absorption curve. The curves are then reduced from a vector length of 401 to a vector length of 331, which are representing the responsivity values (M, L) between the wavelengths (λ) of 385nm to 715nm. These curves are selected to closely resemble measured photon absorption data of the M and L cones[2]. Two monotonic ratio curves are generated for decoding interpolations;

Ratio (M / L) = ln (medium cone responsivity / large cone responsivity)

Ratio (L / M) = ln (large cone responsivity / medium cone responsivity)

NOTE: The Photon Absorption Curves can be seen in the appendix (figure 1).

The second step is to simulate two encoded images, which will represent what will be seen by the medium and large cone detectors. Two matrices are initially generated to simulate both the wavelength and intensity maps of the different objects. The wavelength map is interpolated with the given photon absorption curves, to generate both a medium and large cone responsivity matrices. The intensity map (I)

Investigation and Validation of Submaximal Cycle Ergometry Protocols Used to Assess the Aerobic Capacity of the USAF Population

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Abstract

The United States Air Force (USAF) uses a submaximal cycle ergometry protocol to assess the aerobic fitness level ($\dot{V}O_2$ max) of all members. Weaknesses of the current assessment require either modifications to or replacement of the current protocol. The purposes of this study were to evaluate (1) the Banister-Legge (B-L) protocol (men only), (2) a modified USAF assessment with (USAF+CF) and without a correction factor (USAF), and (3) a new steady state (SS) protocol using the current Air Force equation (SS+CF and SS) to generate $\dot{V}O_2$ max estimates. The B-L protocol significantly underestimated the $\dot{V}O_2$ max of all male subjects. The USAF+CF and USAF significantly underestimated actual $\dot{V}O_2$ max for male subjects. The USAF+CF had a lower mean difference, SEE, and E than the USAF estimation. The USAF+CF significantly underestimated the actual $\dot{V}O_2$ max for females, but the USAF was not significantly different than actual $\dot{V}O_2$ max. The SS and SS+CF both significantly underestimated $\dot{V}O_2$ max for men and women. The mean difference, SEE, and E were all higher compared to the USAF and USAF+CF estimates.

The best $\dot{V}O_2$ max estimates for male subjects in this study were USAF+CF and the best for female subjects were the USAF estimates. Due to the differences between the USAF and SS protocol, using the USAF equation with SS test responses may not be appropriate. With a new prediction equation based upon the SS test responses, the SS test should produce more accurate $\dot{V}O_2$ max estimates. The B-L protocol is not a feasible replacement for the USAF protocol.

Investigation of Conductive Cladding Layers for Improved Poling in Non-Linear Optical Polymer Waveguides

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Abstract

The use of conductive layers to improve poling in non-linear optical waveguides was investigated. Research was centered on conductive layers formed from the conducting polymer poly (ethylene dioxythiophene) (PEDOT), and its blends. Preliminary investigations of other materials are also included. Thin films of these materials were produced by spin casting from solution and were then evaluated for their conductive, thermal and optical properties. These films were subsequently used to produce waveguides and simple Electro-Optic (EO) devices. Results indicate that these conductive layers performed well in EO devices, acting as buffer layers and providing improvements in poling. The conductive layers were also found to exhibit qualities necessary for construction of optical waveguides. Processing and Characterization techniques are presented for the materials investigated, and construction of devices is described.

DIRECT MEASUREMENT OF DNAPL/WATER CONTACT AREA IN THE SUBSURFACE: ONE- AND THREE- DIMENSIONAL STUDIES

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Abstract

A technique for the direct measurement of DNAPL/water contact area in a porous medium was investigated. This technique involves quantitating interfacial tracer sorption at the interface. In the first part of the study, the technique was verified by measuring the water/glass bead contact area in a packed column. Two different tracers, Triton-X100 and SDBS, were used. The resultant contact areas were similar to each other, to a geometrically derived estimate, and to an independent BET measurement. In the second part of the study, this technique was developed further through experimentation in a three-dimensional flow system which simulates a homogeneous phreatic aquifer. DNAPL/water contact area in the flow system was measured using SDBS as the interfacial tracer. Preliminary results indicate that the entire mass of the tracer was eluted. A complete analysis of the data is in progress and publication of a journal article is planned for the near future.

COMPUTER SIMULATION OF FIRE SUPPRESSION
IN AIRCRAFT ENGINE NACELLES

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Abstract

Computer modeling of aircraft engine nacelle fire suppression experiments was performed. This is a continuation of a project begun by Applied Research Associates, Inc. A finite difference program is being utilized to replicate tests conducted using the Aircraft Engine Nacelle Fire Test Simulator. Both the meshed configuration of the engine nacelle and processing parameters used to identify all conditions of the experiments were analyzed and evaluated. Where appropriate, corrections were made to the existing model with the goal being to idealize the physical experiments. Future work with this project will hopefully allow for experiments to be conducted using the computer simulation.

IMPLICATIONS FOR COMPLEX DISPLAY DESIGN PRACTICES

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Abstract

The exponential growth of automated systems is generating demands for sophisticated display design protocols. In general, cognitive engineering practices provide display design solutions that enhance the operator's ability to manage and control complex systems. However, they often do so without adequate modeling of the cognitive system requirements for this process. In effect, while the task and display properties are well defined, the cognitive system of the user remains covert and hidden from the modeling process. This report illustrates that different cognitive organizing principles are induced by different task representations. Further, performance is dependent on the congruent mapping between task, display, and cognitive organizing principle of the operator. By externalizing the organizational principle used by an operator in a given task context, in theory one can develop representations and displays that are congruent with task and cognitive system.

SIMULATION AND MODELING OF NANOELECTRONIC MATERIALS

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Abstract

We designed and developed two computational tools for use in the study of radiation effects in nanoelectronic materials and devices. The first of these tools was a non-orthogonal tight-binding molecular dynamics code. A basic shell was completed, onto which specific modifications will be added to increase applicability to irregular cluster geometries. Both the shell and future modifications are being designed to maximize data parallelism, and we are using a recently-published algorithm that results in $O(N)$ scaling. The second tool is a code for modeling self-organization/self-assembly in nanoelectronic materials. This code uses ideas from the modeling of molecular assembly in biology and polymer chemistry--independent, interacting agents, interactions governed by effective parameters. In our case, these interaction parameters will be determined by small-scale, highly accurate quantum-chemical data.

Demonstration of Genetic Algorithms for Engineering Optimization Problems

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Abstract

This research program focused on the application of Genetic Algorithms to engineering problems. A series of studies was conducted over the duration of the research period to investigate the effectiveness of a GA in different types of problems. Initially, the GA was tested against published benchmark data. It was shown that the GA can obtain the same results as traditional gradient-based methods, but at a much higher computational cost. The GA was then used to solve a three-dimensional aerodynamics problem using QUADPAN (a linear panel method used for computing maneuver loads), and then to solve a series of truss optimization problems with ANALYZE (an in-house structural analysis code). The truss problems highlighted the versatility of GA techniques by demonstrating multi-objective optimization, the use of discrete variables. and the ability to find solutions to problems that are difficult for traditional optimization techniques.

A PRELIMINARY STUDY OF THE CAUSES OF SPRING-IN IN A UNIDIRECTIONAL CARBON FIBER / EPOXY COMPOSITE

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Abstract

Composite materials are advantageous for space applications due to their light weight and high stiffness/weight ratio. However, curved composite parts which are autoclave cured tend to exhibit "spring-in", a permanent deformation due to residual stresses [1], which must be understood to ensure dimensional accuracy of the final part. The purpose of this research is to determine and, if possible, to quantify the principle causes of spring-in in a unidirectional carbon fiber/epoxy composite. This project is intended to form the basis of further research into the spring-in effect to assist the Advanced Grid Stiffened (AGS) Composite Shroud Program at Phillips Labs, Albuquerque, NM. For this first stage of the research, three series of ICI Fiberite IM7/977-2 carbon fiber/epoxy cylindrical hoops were wound on a three-axis winder and autoclave cured according to the manufacturer's recommended cure cycle [2]. These cylindrical parts were then cut to determine the effect of varying parameters such as winding tension and part thickness on the measured spring-in. The findings in this paper are preliminary and represent work to date. Additional research and testing on the spring-in effect in curved composite parts is planned to further clarify the relevant factors involved.

An Examination of Java and CORBA Security

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and

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Abstract

As the power of computer networking continues to expand, a greater effort is being made to harness that power. Two areas of intense activity are executable content, which refers to code which is automatically downloaded and run on a user's machine over a network, and distributed computing, which refers to the distribution over a network of computer tools and applications. In this paper, we look at the security measures associated with two of the approaches taken to distributed computing and executable content. First, in the case of distributed computing, we examine the built-in security associated with Java™ applets. Second, in the case of executable content, we look at the security measure associated with the CORBA™ standard for object request brokers.

MEASUREMENT OF DISPERSIVE CURVES FOR OCULAR MEDIA BY WHITE-LIGHT INTERFEROMETRY

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ABSTRACT

White-light interferometry was used to measure the wavelength dependence of refractive indices (i.e., dispersion) for various ocular components. Verification of the technique's efficacy was substantiated by accurate measurement of the dispersive properties of water and fused silica, which have both been well-characterized in the past by single-wavelength measurement of the index. The dispersion curves were measured from 400 nm to 800 nm for aqueous humor and vitreous humor extracted from bovine eyes. The principles of white-light interferometry, including image analysis, measurement precision, and limitation of the technique, are discussed. In addition, alternate techniques and past measurement of ocular dispersion are reviewed.

GENDER EFFECTS IN WAYFINDING STRATEGY:
IMPLICATIONS FOR
TEAM AND INDIVIDUAL TRAINING

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ABSTRACT

Data from two studies are presented which suggest that individuals choose differing strategies for wayfinding, based upon their strengths and preferred cognitive styles. While one strategy does not necessarily convey a benefit for real-world navigation, the literature indicates that individuals who use strategies that emphasize orientation rather than object location tend also to have an advantage in certain spatially-related tasks that demand dynamic re-orientation, such as Unmanned Arial Vehicle (UAV) operation.

Because of the potential consequences of strategy choice, a study is proposed that will test whether a training manipulation can affect a particular individual's choice of strategy for wayfinding. The outcome of the proposed study will have important implications for the training of individuals to perform such spatially demanding tasks as the operation of UAVs.

COMPARISON OF SELF-ASSEMBLED MONOLAYERS AND CHITOSAN AS FUNCTIONAL SUBSTRATES FOR DEPOSITION OF ULTRATHIN PHOTORESPONSIVE FILMS.

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Abstract

Chitosan, an extract from the exoskeleton of arthropoda is compared to a traditionally prepared self-assembled monolayer (SAM) for its suitability as a functional substrate in constructing multilayers of C60-Porphyrin. Measurement of topography, friction, chemical composition, mechanical stiffness and stability of the surface was performed by adaptation of recently developed atomic force microscope (AFM) procedures. While the SAM has a theoretically superior surface character as a substrate for multilayer photoresponsive films, the chitosan was found to be superior in qualities critical for adsorption and mechanical stability. This is due to the different distribution and mechanical stabilization of surface functional amine groups controlled by the helical intramolecular structure of chitosan macromolecules.

SIMILARITY MEASURES
FOR
PATTERN RECOGNITION

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ABSTRACT

What similarity is and how it is measured is fundamental to pattern recognition. A survey of recent literature resulted in this report's description of similarity measures for many types of data representations. These include:

-- Points

-- Point Sets

-- Contiguous Point Sets (Shape and Texture)

-- Attributed Relational Graphs (Parameterized Structural Descriptions)

For these data representations, what makes two patterns similar is that they are alike as concerns some significant characteristic. Unfortunately for the designer of pattern recognition algorithms, significant characteristics are problem dependent and may be hidden within the data, unknown to the algorithm designer. Thus the designer should consider many different problem and data representations, along with their accompanying similarity measures.

EVALUATION AND INTEGRATION OF ELECTRODYNAMIC SIMULATION PACKAGES FOR MADMEL PROGRAM

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Abstract

In order to study various electromagnetic effects pertaining to the More Electric Aircraft Initiative a package of simulation software was assembled by Honeywell Technology Center under the contract of Wright Laboratory's Aerospace Power Division, Aerospace Propulsion and Power Directorate. The main objective was to establish a relatively easy to use, workstation based simulation package that could be used together or singly to simulate a wide variety of real world problems. This report consists of an evaluation of the software, a brief description of how the software works and can interact with one another and, as an added appendix available in building 450 at Wright Patterson Air Force Base Area B, a simplified user's manual for each program.

EXAMINATION OF AN ORGANIZATIONAL CLIMATE MEASURE
AND THE RELATIONSHIP WITH GRIEVANCES AND TURNOVER

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Abstract

An organizational climate survey given to both military and civilian employees at a Midwestern Air Force Base was examined to determine the stability of the measure and the longitudinal effects that climate has on grievance and turnover rates at the organizational level. The climate scales were relatively stable across the years examined. Limited relationships were found between the climate scales and either grievances or turnover. The multidimensionality of organizational climate became evident. In particular, three scales demonstrated a number of significant or marginally significant correlations. The three scales were determined to compose a leadership dimension of climate, and the relation of the leadership dimension with grievance and turnover rates was then examined. A number of limitations and suggestions for future research are discussed.

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. Research Assistant

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Abstract

Exploding Foil Initiators (EFI) flyer plate velocities were the focus of this research. Using laser velocity interferometer system for any reflecting surface (VISAR), a procedure for measuring EFI flyer plate velocities was developed to complement existing procedures for measuring electrical characteristics. The VISAR velocity data combined with electrical characteristics will be incorporated into an existing numerical model predicting the electrical behavior of the EFI. This unified model will then be able to predict EFI mechanical performance as a function of the electrical parameters. This model can then be used to predict the behavior of more complicated systems such as air bag initiation devices utilizing a particular EFI device..

CAPACITOR BASED DC BACKUP POWER SUPPLY
WITH INTEGRATED CHARGING CIRCUIT

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Abstract

A capacitor based DC backup power supply with an integrated charging circuit was studied. The design utilized the relatively new 10-F 2.5V capacitors as the energy storage units. The constant output voltage was maintained by a Pulse Width Modulated (PWM) boost converter with both feedforward and negative feedback control.

OPERATIONAL ANALYSIS OF AN ACTIVELY MODE-LOCKED FIBER LASER

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Abstract

This paper describes the construction and operation of an actively mode-locked fiber ring laser. The inclusion of a lithium niobate Mach-Zehnder modulator into a fiber ring cavity permits self-starting and external control of the repetition rates of the laser. The modulator and a sythesized frequency generator mode-locked the laser at frequencies ranging from 1.5 MHz to as high as 5 GHz. An experimental and theoretical analysis of the pulse shaping mechanisms is included as is an examination of the output noise at both low and high repetition rates. The paper concludes with an investigation of rational harmonic mode-locking, a novel method of increasing repetition rates while applying only modest drive signals.

A PRELIMINARY ANALYSIS OF STACKED BLUMLEINS USED IN PULSED POWER DEVICES

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Abstract

A computational model of stacked Blumleins used in pulsed power devices was initiated. Moment method calculations were completed using MATLAB in order to determine the charge densities of the flat, parallel conducting plates comprising the Blumleins. Preliminary findings indicate that fringing electric fields do exist and should affect the output of the pulser, especially in the high-frequency regime. Further analysis is required for a more decisive and complete picture of pulse propagation along the Blumleins.

HUE ANALYSIS FACTORS FOR LIQUID CRYSTAL
TRANSIENT HEAT TRANSFER MEASUREMENTS

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Abstract

Hue Analysis is one approach for using liquid crystals to measure transient heat transfer in high speed flows. The indications given by wide-band crystals that are used to determine temperature, however, are highly sensitive to flow conditions, model material properties, viewing angles and illumination, and framegrabbing rate. This study used the hue capture range and duration of crystal colorplay as a measure the significance and influence of these factors in providing sufficient information to accurately measure temperature changes. An Experimental Design approach was used to define the test strategies and analyze the data. It was found that materials with high $(\rho ck)^{1/2}$, $k/\rho c$, and wide bandwidth crystals are the most critical factors. The hue analysis was then applied to various model geometries to illustrate the use of liquid crystals to measure heat transfer, and identify various boundary layer features.

A SIMULATION STUDY ON A PARTITIONING PROCEDURE
FOR RADAR SIGNAL PROCESSING PROBLEMS

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Abstract

This paper contains the simulation results on trials of a partitioning procedure developed in a paper by Chen, Melvin and Wicks (1995), for screening k multivariate complex normal populations, with respect to a control population for homogeneous noise covariance matrices. The probability of a correct partition under the least favorable configuration, was used as a performance measure on these simulation trials. Other performance measures evaluated were expected subset sizes, expected number of good populations for each partition, expected number of bad populations for each partition, probability of false alarm and the probability of detection.

EXPERIMENTAL VALIDATION OF THREE-DIMENSIONAL RECONSTRUCTION OF INHOMOGENEITY IMAGES IN TURBID MEDIA

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Abstract

Near infrared radiation for imaging tumors in tissue has been recently explored and investigated. In particular, to validate a novel FFT imaging reconstruction algorithm, we have performed experiments on tissue phantoms using a frequency-domain photon migration system. The system includes an amplitude-modulated laser diode, two radio frequency (RF) signal generators, an avalanche photo detector, and a lock-in amplifier. The tissue phantoms were made with inhomogeneities imbedded and were then scanned with the system at various RF frequencies. The data from the amplitude and phase measurements were analyzed using the FFT reconstruction algorithm. The reconstructed data show clear validation of the FFT algorithm and afford to localize inhomogeneities hidden in turbid media in three dimensions. In addition, based on the results, we present preliminary analysis on optimization of experimental parameters to obtain good-quality, reconstructed images with best experimental efficiency.

A CLEARANCE STUDY OF NITROTYROSINE
FROM A PROSTATE CANCER CELL LINE

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Abstract

Formed by the reaction of superoxide with nitric oxide, peroxynitrite has been implicated in interfering with normal signal transduction pathways via its formation of nitrotyrosine. In carrying out the following experiment, our aim was to determine the clearance of nitrotyrosine from a human metastatic prostate cancer cell line, specifically, LnCap cells. In particular, we hope to deduce any specific mechanisms that may be involved in the clearing of nitrotyrosine which may be indicative of peroxynitrite repair. To this end, we needed to establish the smallest possible dose of PN that is required, but yet, not be lethal to the cell. The possible dose was determined from a previous pharmacodynamics study that was conducted of peroxynitrite in LnCap cells, here, we were able to establish that there is a significant (< 0.05 relative to control) loss of membrane integrity only at the 1mM PN dose 1 hr (7.7%) and 4 hour (23%) after exposure but not at 24h. Thus, following a 1mM PN exposure, cell numbers and viability were determined over a period of 3 days and quantitation of the extent of protein nitration was determined via a flow-cytometry protocol.

RELATIONSHIP BETWEEN GROWTH HORMONE
AND MYELIN BASIC PROTEIN EXPRESSION *IN VIVO*

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ABSTRACT

Proper functioning of the mammalian nervous system requires myelination of neuronal axons. Myelination of the newborn mouse brain begins shortly after birth and is complete by about 20 days of age. Abnormalities of myelin basic protein (MBP) production have a direct impact on myelination as has been demonstrated in the shiverer mouse. Mice with less than 25% of normal MBP levels have aberrant myelination and brain development and demonstrate a characteristic tremor at 12 days of age. Growth hormone (GH) and insulin-like growth factor I (IGF-1) have been shown *in vitro* and *in vivo* to affect myelination. This project explores the effect of GH deficiency on myelin basic protein expression to determine whether the GH deficiency exacerbates MBP haploinsufficiency. These studies grew out of studies undertaken on children with 18q- syndrome who have only a single copy of the MBP gene, are hypomyelinated, and are also shown to suffer growth hormone deficiency or insufficiency. A hybrid mouse model which mimics these deficiencies of 18q- patients is being developed to explore the reltationship between GH and MBP *in vivo*.

A STUDY OF ELECTRONICS DESIGN ENVIRONMENTS
IN TERMS OF COMPUTER AIDED DESIGN:
A PSYCHOLOGICAL PERSPECTIVE

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Abstract

The Electronics Design Environment in terms of Computer Aided Design was studied. In order to design an effective user interface, a program which displays a sequence of words, followed by the word stems of the previously presented word was written in Java in order to assess how much information the user can process before information overload occurs. The user will be asked to complete the word stem based on the given instructions of inclusion (consciously using one of the previous words to complete the word stem) or exclusion (consciously not using one of the previously presented words to complete the word stem). If an individual, under exclusion instructions, uses the previously presented words to complete the word stems this will provide evidence that their response was not due to conscious control. Jacoby (1991) coined this procedure as the Process Dissociation Model. To test whether or not unconscious processing has occurred due to information overload, the appropriate statistical measure will be used.

FATIGUE CRACK GROWTH BEHAVIOR
OF Ti-22Al-23Nb

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Abstract

The fatigue crack growth (FCG) behavior of an orthorhombic titanium aluminide alloy has been investigated for two microstructural conditions: a duplex microstructure consisting of 5 vol.% globular α_2 phase within a two phase mixture of orthorhombic platelets in a continuous β_0 matrix, and a fully transformed microstructure containing only the orthorhombic and the β_0 phases. FCG tests were conducted at room and elevated temperature in lab air. Results indicate no significant difference between the two microstructural conditions with regard to their da/dN-ΔK behavior for both 20°C and 540°C testing in lab air, except for the cyclic fracture toughness values, which are higher for the duplex microstructure. Initial results of vacuum FCG testing at room temperature show that the da/dN-ΔK curve is shifted to the right in the threshold regime as compared to the equivalent curve obtained in lab air, indicating an environmental effect. Furthermore, the fatigue crack propagation behavior at 540°C is superior to the room temperature behavior over most of the ΔK range investigated. Fractographic analysis indicates a predominantly transgranular failure mode for both microstructures, with a more brittle appearance at room temperature than at 540°C.

A QUASI-PARTICLE ANALYSIS OF AMPLITUDE SCINTILLATION

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ABSTRACT

A quasi-particle approach is applied to study amplitude scintillation of a transionospheric signal associated with bottomside sinusoidal (BSS) irregularities in the equatorial F region of the ionosphere. The power spectrum of a three second sample of high-resolution density perturbation data obtained in situ, by the low orbiting Atmosphere-E (AE-E) Satellite (orbit 22700, 12/11/79) during its passage through BSS irregularities, is modeled analytically by a superposition of three functions, which define the scatterer of the quasi particles. Numerical results are presented, and their physical significance discussed.

THE EFFECT OF 2.06 GHz MICROWAVE IRRADIATION ON THE PERMEABILITY OF THE BLOOD BRAIN BARRIER

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ABSTRACT

It has been demonstrated that the intact nature of the Blood Brain Barrier (BBB) has the ability to be compromised by exposure to electromagnetic field radiation. Previous studies were conducted in an effort to determine whether the induced breakdown of the BBB may be attributed to microwave irradiation or hyperthermia. In our study, we hypothesized that the permeability of the BBB may be altered by an induced hyperthermia as the result of exposure to microwave irradiation. Four groups of rats were created based on the method of Albumin permeability analysis. Groups included qualitative analysis of Sodium Flourescein (4%) and Evan's Blue, immunocytochemical analysis of Albumin and spectrophotometrical analysis of 0.5% Sodium Flourescein. Rats were exposed to 2.06 GHz microwave irradiation at power densities of 40 mW/cm^2 and 130 mW/cm^2. In addition to experimental animals, positive control and sham- irradiated animals were included in each group. It was found that power densities less than 130 mW/cm^2 were unable to induce a hyperthermic event and no Evan's Blue tracer was detectable in the brain. However, exposure to 130 mW/cm^2 induced leakage of Evan's Blue and was additionally accompanied by tympanic temperatures above 43.2°C. Presently, results are inconclusive based on the incomplete studies of the Sodium Flourescein and Albumin subjects.

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Abstract

Semiconductor bridge ignitors (SCB) were characterized electrically and mathematically. The voltage and current measurements of the devices were analyzed during excitation by high currents. From these measurements, the resistance, energy and specific action versus time were determined. A mathematical model of the resistance versus energy was then developed. In the near future a more depth analysis will be done on the SCB.

A SETUP FOR PHOTOASSOCIATION
OF
COLD, TRAPPED CESIUM ATOMS

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Abstract

An existing Magneto-Optical Trap (MOT) setup was modified to allow for photoassociation studies. A photoassociation laser was directed towards the trapping cell, and a system for molecule detection was installed, consisting of a photoionization laser, and channeltron detection. Initial attempts at photoassociation were unsuccessful, but work will continue in this area, now that the groundwork has been completed.

RESEARCH ON PLASMA DIAGNOSTICS FOR VERSATILE TOROIDAL FACILITY: GRIDDED ENERGY ANALYZERS

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Abstract

Gridded Energy Analyzers (GEA) are useful diagnostic tools for determining plasma ion energy distributions and ion temperature. The Versatile Toroidal Facility (VTF) at MIT's Plasma Science and Fusion Center provides a laboratory environment for studying ionospheric plasmas. Research was done on the theory behind Gridded Energy Analyzers and their applicability for use in the Versatile Toroidal Facility. A design and method for constructing a miniaturized GEA for VTF was developed and documented.

A PROTOCOL FOR DEVELOPMENT OF AMPLICONS FOR A RAPID AND EFFICIENT METHOD OF GENOTYPING HEPATITIS C VIRUS FROM CLINICAL SERUM SPECIMENS

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Abstract

The two goals of this research project were to (1) establish a procedure to confirm the presence of Hepatitis C Virus (HCV) in serum and (2) to establish a procedure to obtain unique amplicons suitable for genotyping HCV specimens. HCV detection needed to be simple and rapid for use in a clinical laboratory setting. Genotyping of HCV is necessary for further epidemiological studies and assessment of risk to military personnel deployed worldwide. This research examines two protocols for (1) a PCR-based assay to test for HCV RNA (antigen) and (2) isolating viral RNA and preparing cDNA for a PCR-based method for genetic typing of HCV variants. Our results indicate the potential for exploring novel applications of current technology to rapidly genotype HCV variants in the clinical laboratory setting. This work will continue throughout the year at the Institute of Molecular Biology and Medicine (University of Scranton) in collaboration with the Air Force Epidemiology Research Division (Armstrong Laboratory) and the University of Texas School of Public Health.

AN PSYCHOMETRIC EXAMINATION OF THE MULTIDIMENSIONAL WORK ETHIC PROFILE AMONG AIR FORCE ENLISTED PERSONNEL

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and
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Abstract

The present study examines the psychometric properties of the Multidimensional Work Ethic Profile (MWEP) developed by Michael Miller and David Woehr (Woehr & Miller, 1997, Miller and Woehr, 1997) with Air Force enlisted personnel. The MWEP is a multidimensional measure of work ethic based on previous literature and research focusing on work ethic and job performance. Originally developed based on a sample of university students, the MWEP has demonstrated good psychometric characteristics including reliability and validity. The MWEP has been suggested as a potentially valuable screening tool with Air Force enlisted personnel. The purpose of the present study was to provide a preliminary evaluation of the measure among Air Force enlisted personnel. Results indicate that the measure does demonstrate similar psychometric characteristics among Air Force enlisted personnel as with the original developmental sample. The MWEP provides reliable and valid measures of multiple dimensions underlying the work ethic construct. These results indicate that the MWEP may be a useful screening tool for Air Force Personnel.

THE EFFECT OF SIZE DISPARITY ON PERCEPTION OF SURFACE SLANT IN MOTION CONTEXTS

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Abstract

This study focuses on the effects of horizontal, vertical and overall-size disparities on perceived surface slant under both static and motion conditions. The effect of superimposed zero-disparity contrast stimuli was also measured. The response patterns from all test conditions show no distinction between moving versus static disparity images. The results corroborate the previous findings by Pierce & Howard (1996) and Kaneko & Howard (1996) that a superimposed zero-disparity contrasting image effects the perceived inclination of the disparity surface. New interactions between vertical size disparities and a superimposed zero-disparity horizontal line are presented.

THE ROLE OF MULTI-MODAL ADAPTIVE INTERFACES IN PROVIDING FLIGHT PATH GUIDANCE

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Abstract

Advances in weapons capabilities and reduced target detectability are requiring fighter pilots to make more time-critical decisions in a shorter period of time (Hettinger & Haas, 1993). Operating in such an environment leads to reduced situational awareness, increased workload, and potentially life-threatening errors. One means proposed to help alleviate the excessive demands imposed on pilots is through the use of real time *adaptive interfaces* which are continuously modified based on the internal state of the pilot, the behavioral pattern of the pilot, and environmental-external events (Hettinger, Cress, Brickman, & Haas, 1996). Simply stated, the goal of adaptive interfaces is to provide the right information, in the right format, at the right time (Bennett, 1997). However, prior to achieving this goal there are a number of issues which must be addressed (Hettinger et al., 1996). First, the conditions under which an adaptive interface will facilitate performance must be identified. Second, rules to guide the appropriate modification of adaptive interfaces must be generated. More simply, the "when" and "how" of adaptive interfaces must be determined.

The proposed study is designed to address both of these issues within the context of a tactical flight environment. The research described in this proposal will examine the performance implications afforded by the use of multi-modal adaptive interfaces during the recovery-to-pathway segment of a precision navigation flight task. This research will examine the implementation of visual and auditory interfaces designed to aid the pilot in returning to the correct course following the completion of maneuvers performed while evading a surface-to-air missile. The results of this research will have implications for the development of future adaptive interfaces. Specifically, this study aims to identify the conditions under which multi-modal interfaces should be employed and the types of adaptations which will prove beneficial.

Desorption and Aerobic Biodegradation of Dinitrotoluenes in Aged Soils

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Abstract

A study on the desorption kinetics and the biodegradation of dinitrotoluenes in aged soils was performed. Aged clayey soil contaminated with 2,4-DNT, 2,6-DNT, and 2,4,6-TNT was obtained from the Volunteer Army Ammunitions Plant in Chattanooga, Tennessee. The average extractable concentrations of 2,4-DNT, 2,6-DNT, and 2,4,6-TNT were 0.278 ($\pm$.004), 0.079 ($\pm$.002), and 0.297 ($\pm$.004) mg/g, respectively. The organic carbon content (f_{oc}) was 0.70 ($\pm$ 0.09)%. Using Tenax beads as an infinite sorptive sink, sequential desorption experiments were performed to measure the long-term desorption of DNT and TNT from the soil: 76% and 89% of the extractable nitrotoluenes were desorbed from the soil in one and three days, respectively. Biodegradation of the DNTs was measured in factorial soil slurry experiments. 2,4-DNT was readily available for degradation by the indigenous microorganisms. Complete mineralization, as evidenced by near stoichiometric NO_2^--N release, was achieved within 5 days. Addition of a known 2,4-DNT and 2,6-DNT degrading bacterial strain did not show any benefit. Little mineralization of 2,6-DNT was observed. Additional experiments were performed to evaluate the toxicity or inhibition of 2,6-DNT and TNT towards 2,6-DNT mineralization. The addition of either Tenax beads to reduce the aqueous concentration of 2,6-DNT and TNT or an induced 2,6-DNT degrader (JS922) to the soil slurries did not stimulate 2,6-DNT biodegradation. In separate experiments, it could not be confirmed that TNT at 25 mg/L negatively impacted 2,6-DNT mineralization by JS922. The above work indicates that rapid desorption of nitrotoluenes from the clayey soil tested makes compounds such as 2,4-DNT and 2,6-DNT readily available for biodegradation; that indigenous microorganisms can readily mineralize 2,4-DNT; while stimulation of 2,6-DNT mineralization appears difficult.

IMPLEMENTATION OF FREFLEX/MERLIN TELEOPERATION

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Abstract

This report summarizes the author's work in the AFOSR 1997 Graduate Student Research Program, based in the Human Sensory Feedback Laboratory of Armstrong Laboratory, located at Wright-Patterson AFB. A powerful and general control architecture is being implemented for real-time, sensor-based, rate-based, shared control of a *Merlin* industrial robot with the unique *Freflex* force-reflecting exoskeleton. This work is the first time the *Freflex* exoskeleton has been used for teleoperation of the *Merlin* slave manipulator. A description, including operating procedures, of the teleoperation resources of the Laboratory is included within the report. Additional accomplishments are the novel Naturally-Transitioning Rate-to-Force Controller (NTRFC) and a *Matlab* simulation of *Freflex/Merlin* teleoperation under joint and Cartesian pose and rate control.

WELL-POSEDNESS FOR A CLASS OF NONLINEAR DISTRIBUTED PARAMETER MODELS WITH TIME DELAY ARISING IN ADVANCED TOXICOKINETIC MODELING

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Abstract

Well-posedness of solutions was studied for a mathematical model to describe the uptake and elimination of TCDD in humans. The model includes spatial dispersion in the critical organ (the liver), time delays in tissue response, and nonlinear chemical kinetics within cells. We present a global existence and uniqueness result for a class of abstract nonlinear parabolic delay systems and discuss well-posedness for the TCDD model.

SIMULATION OF A ROBUST LOCALLY OPTIMUM RECEIVER IN CORRELATED NOISE USING AUTOREGRESSIVE MODELING

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Abstract

This report presents the simulation of a robust *locally optimum* (LO) non-linear spread spectrum receiver. The signaling environment consists of the desired received signal in correlated interference and thermal noise. Autoregressive (AR) spectral modeling methods and a histogram approximation of the probability density function are employed. Preliminary results for transmission in the presence of *continuous wave* (CW) and *partial band* (PB) interference are presented and discussed. A comparison of this method to a similar nonlinear processing algorithm is performed. Preliminary results for the performance of a binary phase-shift keyed communications system indicate that applying AR modeling to the environment improves performance substantially, especially in the case of partial band interference.

A TECHNIQUE FOR LOCATING AND CHARACTERIZING CRYSTALLINE REGIONS IN SIMULATED SOLIDS

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Abstract

Software was developed which examines simulated solids and searches for crystalline regions in them. This is accomplished by forming a set of three lattice vectors, and using them to determine which atoms in the sample should be included in a particular crystalline region. Software designed in this manner can detect crystalline regions of arbitrary symmetry, and can even be made to accommodate lattices which are imperfect. The lattice vectors can also be used to determine if a particular crystalline region is of one of the common lattice types (FCC, BCC, etc). This information provides a useful means of characterizing the results of molecular dynamics simulations.

ORGANICALLY MODIFIED SILICATE FILMS AS CORROSION RESISTANT TREATMENTS FOR 2024-T3 ALUMINUM ALLOY

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Abstract

Organically modified silicates (ormosils) sol-gel films coated on aluminum alloy 2024-T3 coupons were investigated for the purpose of developing an environmentally-compliant replacement for chromate-based surface treatments. The effect of surfactants, hybrid organic content, and alkoxide size effects on resultant films were evaluated for corrosion protection in comparison to Alodine-1200 type surface treatments. Results indicate that pinhole surface defects were present in most films; these limit the ultimate performance of sol-gel treatments. Even with pinhole defects, however, 4 orders of magnitude improvement in corrosion protection was demonstrated for sol-gel treated coupons with respect to Alodine 1200 surface treatments. Selected single-layer sol-gel compositions were found to rival the performance of the chromate-laden paint system (e.g., Alodine/primer/topcoat) currently used by the Air Force.

A Study of Atmospheric Perturbations
On a Suborbital Space Plane
Skipping Trajectory

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Abstract

A study was conducted to investigate the possibility of a suborbital global reach military space plane, using the Gram-95 atmospheric model integrated with the trajectory analysis code POST 3D. The ability to perturb the atmosphere through GRAM-95 provided a look at the possible problem areas with regards to this specific mission design. Items pointed out include heat rates, total heat, diurnal variations, and dynamic pressures.

COST-BASED RISK PREDICTION AND IDENTIFICATION OF PROJECT COST DRIVERS USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

This research investigated the effectiveness of using Artificial Neural Networks (ANNs) to predict risks related to final project costs and to identify potentially significant cost drivers relating to construction projects. Several ANN models were developed which related potential project costs to a variety of input factors typically used to perform conceptual cost estimating. Using the intrinsic feature representation properties of ANNs, cost drivers were identified which should be managed for projects to reduce the risks of cost growth. Results of the research indicate that ANNs can serve as a robust tool for cost estimation and approximated multivariate regression analysis.

A NEW TECHNIQUE USED TO DETERMINE THE TIME EVOLUTION OF THE FREQUENCY IN HETERODYNE SYSTEMS

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Abstract

Determining the time rate of change of frequency from heterodyne signals is difficult. Many methods have been attempted in solving this problem. Both the zero point and least squares method result in gross overestimation or underestimation of the frequency when the frequency is changing with time. This causes improper determination of competing modes and frequency chirping in waveguides. The method described in this report utilizes the model of sinusoids. Results show this model is more accurate than the zero point and least squares method. The Interactive Data Language (IDL)[2] by Research Systems, Inc. is used for the programming so the analysis can be immediately executed upon obtaining the data.

A Study of Intra-Class Variability in ATR Systems

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Abstract

In this report we describe the results of our investigation into the intra-class variability of a vehicle class from the perspective of an automatic target recognition system. We examine the relevance of synthesized vehicle models for ATR systems and conclude that these models fall within the bounds of the vehicle class set by the intra-class variability of the vehicle. We also demonstrate the relevance of the mean-square-error between an image chip and a template when used as a measure of distance between the physical vehicles. We also show that it is feasible to intelligently merge chips from different vehicles of a class and construct classifiers that perform better than those designed with any individual member of the vehicle class.

Investigation of the Iron-Bearing Phases
of the Columbus AFB Aquifer

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Abstract

This work was a part of the USAF Natural Attenuation Study (NATS) to determine whether natural attenuation is a cost effective and practical remediation technique for organic contaminants in aquifers. It was part of a multifaceted experiment designed to investigate the availability of the iron-bearing phases for use by indigenous, iron-reducing microbes in the degradation of organic groundwater contaminants at Columbus Air Force Base (CAFB), Columbus, Mississippi. The research focused on three topics: (1) the characterization of the iron phases in the CAFB aquifer materials by selective extraction methods; (2) method development for working with anaerobes, for future laboratory studies; and (3) demonstration of the abiotic production of magnetite, thus indicating that magnetite is not an exclusive indicator of microbial degradation under iron-reducing conditions.

An LPV Controller for a Tailless Fighter Aircraft Simulation

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Abstract

Linear parameter-varying (LPV) controllers were developed for the short-period longitudinal and roll and Dutch-roll lateral-directional dynamics of the McDonnell Douglas Tailless Advanced Fighter Aircraft (TAFA) flight-vehicle simulation. In linearized simulations, the controllers were shown to exhibit Level 1 handling qualities for Mach numbers below 0.7. Controller stability and performance were verified in simple nonlinear simulations.

WHISTLER WAVE CUTOFF AND EM EMISSIONS IN THE LABORATORY AND THE IONOSPHERE

Michael J. Rowlands

Abstract

Electromagnetic waves, propagating parallel to the magnetic field in a magnetized plasma, are detected in the Versatile Toroidal Facility, (VTF), up to the electron cylcotron frequency. Since plasmas in VTF are formed from either electron beams or microwaves, the plasma densities are in the shape of a single crest. Ionospheric theory predicts that these electromagnetic waves, called whistler waves, can only be ducted up to half the cyclotron frequency in a crest. This discrepancy between theory and experiment was investigated and an adapted theory was developed for VTF conditions. Electromagnetic emissions and wave-particle interactions in the magnetosphere were also analyzed.

A PRELIMINARY STUDY ON THE EFFECTS OF PROCESS CONDITIONS ON CURVATURE IN GRAPHITE/EPOXY PULTRUDED RODS

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ABSTRACT

Pultrusion is a cost-effective and highly mechanized process for manufacturing advanced fiber reinforced plastics (FRP) composites. Studying advanced pultruded composites is relevant for the manufacture of lightweight structural components for the 'Precision Deployable Space Structures' program of the Air Force. Space based radars currently being pursued by NASA and the Air Force will require long (up to 200ft) supporting structures in order to accommodate the larger optics which will be utilized to increase resolution and obtain more precise images. A critical requirement for these supporting structures is to maintain part straightness; therefore, investigation of process conditions during pultrusion was conducted to determine the contributing variables effecting curvature.

THE EFFECT OF VISUAL SIMILARITY AND REFERENCE FRAME ALIGNMENT ON THE RECOGNITION OF MILITARY AIRCRAFT

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ABSTRACT

Aircraft similar in appearance (homogeneous) and dissimilar in appearance (heterogeneous) were studied at orientations consistent with the environmental frame of reference (canonical) or inconsistent with the environmental frame of reference (non-canonical). Response time data for correct identifications indicate that identification performance was better for heterogeneous than homogeneous aircraft. This performance advantage for heterogeneous aircraft was found at both the original training orientations and for novel orientations. Canonical orientations during learning produced better identification performance than non-canonical orientations. Implications for aircraft recognition training are discussed.

ISO-OCTANE AND N-HEPTANE LAMINAR FLAME NUMERICAL STUDY

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Abstract

Detailed reaction mechanisms for n-heptane and iso-octane are compared to new experimental data. Disagreement between the extensively investigated and verified n-heptane mechanism and the experimental data are explained by suspected mass balance discrepancies in the experimental data. This hindered evaluation of the proposed iso-octane mechanism. The trends exhibited by the proposed mechanism are not inconsistent with expectations. Primary consumption paths for the proposed iso-octane sub-mechanism are identified and an ad-hoc sensitivity analysis of the iso-octane sub-mechanism is performed.

OH RADICAL REACTION RATE CONSTANT AND PRODUCT STUDY OF 2-PROPOXYETHANOL

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Abstract

The rate constant for the reaction of 2-propoxyethanol and OH radicals was studied using the relative rate technique. A preliminary study of the products was also made. 2-Propoxyethanol was placed in a Teflon bag with a reference compound, methyl nitrate, nitric oxide, and compressed air. The mixture was photolyzed and subsequently analyzed via GC - FID. Four reference compounds (n-nonane, n-hexane, dodecane, and 1-heptanol) were used to improve the accuracy of the rate constant. The runs done with n-nonane and n-hexane were so erratic that they were discarded. The two references that were used gave little overlap even considering statistical error in 95% confidence interval. Runs with dodecane received a rate constant of $27.2 \pm 4.4 \times 10^{-12}$ $cm^3 molecule^{-1} s^{-1}$ and runs with 1-heptanol received a rate constant of $19.0 \pm 3.8 \times 10^{-12}$ $cm^3 molecule^{-1} s^{-1}$. Experimental results indicated that a systematic error was occurring each day but was random in between days. Several changes were made to the equipment to narrow down the cause of the problem, however the problem still appeared. Future suggestions are to replace the collection trap, where active sites might be forming and causing compounds to stick, and perhaps try a different column.

A STUDY OF HRR SUPER RESOLUTION ANALYSIS
FOR POSSIBLE ATR PERFORMANCE ENHANCEMENT

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ABSTRACT

The possible benefit super resolution can provide to High Range Resolution Automatic Target Recognition was studied. Moving and Stationary Target Recognition data was processed to yield target to clutter ratios indicative of moving target High Range Resolution signatures. This data was reduced in resolution and used to generate the parametric model based quantities necessary to simulate resolution enhanced signatures. These simulations were compared to resolution reduced and full resolution signatures to gauge accuracy of estimates and possible Automatic Target Recognition enhancements respectively.

INVESTIGATION OF AN EXPLOSIVELY FORMED FUSE USING MACH2

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Abstract

A particular type of opening switch, known as an explosively formed fuse, capable of transferring mega-joules of electrical energy within a few microseconds is simulated using the magneto-hydrodynamic code, MACH2. In the simulations, an electrical current is made to flow in a thin foil that surrounds the explosive material. The explosion causes the foil to effectively lengthen and thin, thereby increasing its resistance. Preliminary calculations; with a time-independent current of 1 kA were performed. The results indicate the necessary considerations for thoroughly modeling such a device. Aspects such as hydrodynamics, magnetic flux compression, and resistive diffusion are discussed.

THE EFFECTS OF OBSERVATION AND TRAINING SCHEDULE ON
THE ACQUISITION OF A COMPLEX COMPUTER BASED TASK

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Abstract

The effects of observation and training schedule on the acquisition of complex computer based task are being studied using a 2 (Observation) x 2 (Training) x 2 (Experience) between subjects design. Participants consist of 240 males and females who are divided into 8 different experimental conditions. Participants either observe a model play several sessions of Space Fortress or they play Space Fortress without any observation. The skill level of the model varies as does the number of observation and practice trials. Average scores on the test sessions for Space Fortress will be analyzed in using a 2 (observation) x 2 (Training) x 2 (Experience) x 6 (Tests) mixed factors analysis of variance (ANOVA). It is expected that there will be a main effect of observation and a main effect of experience. In addition there may be an interaction between experience and training schedule and with observation and training schedule. Furthermore, a three way interaction between observation, experience and training schedule would not be unexpected. Therefore, we predict that observation can be useful for facilitating the training of a complex computer based skill once the proper training schedules and model characteristics are defined.

Detection techniques use in forward-looking radar signal processing system:
A Literature Review

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Abstract

(FLAR) Forward-looking airborne radar system, as oppose to (SLAR) side looking airborne radar, allows high target to background contrast, accurate azimuth estimates, day and night operation, and can, to a limited degree, penetrate fog, haze, and dust. On the down side, forward-looking IR radar has range uncertainty, generate false alarm from background clutter, has difficult with occlusion of targets by vegetation and terrain, and is aspect angle dependent. The concept of detection and identification of targets, in nonstationary environment and obscure by inteferences such as clutter, jammer, and noise entails suppressing these inteferences with effective signal processing scheme.

In this report, we will present a comprehensive review of the different STAP algorithms and Neural Network methods, without analytical justification of these algorithms and methods, use for detection of target, obscured by interference such as clutter, Jammer, and noise, applicable to forward-looking airborne radar system.

INTEGRATING MULTISENSORY DISPLAYS FOR AN ADAPTIVE TARGET LEADING INTERFACE

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Abstract

An important research issue in the advancement of tactical cockpit interfaces is the determination of optimal mappings between information display and the perceptual capabilities of operators. Rapid and accurate acquisition of target positions is mission critical in these dynamic, multi-task environments, but the human factors which determine the success of situational information portrayal have not been thoroughly exploited. A promising approach to spatio-temporal data presentation is the use of multisensory interfaces that take advantage of natural perception and action behaviors. This study will collect target tracking, course deviation, and task workload measures for several different configurations of separate and integrated multi-sensory (head-mounted-visual and spatialized audio) target position displays during immersive threat localization/flight navigation simulations. Certain display configurations make use of an adaptive algorithm which will switch information delivery between visual and auditory channels depending on the target's current position with respect to the pilot's field-of-view (FOV). It is expected that the adaptive interfaces will improve target localization rate and efficiency over fixed single channel displays, comparable to the improved performance found with redundant multisensory displays. The multisensory displays should also reduce flight course deviations as pilots will be able to attend visually to boresighted navigational displays while information about targets beyond FOV will be displayed aurally. The anticipated performance benefits generated by situation-specific information portrayal are also expected to manage pilot workload. The results will lead to guidelines for the effective implementation and use of multisensory spatial information displays, as well as adaptive interfaces in general.

A PRELIMINARY EXAMINATION OF ECL ACTIVITY GEARED TOWARD A CD^{+2} SENSOR

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Abstract

Pollution is a growing concern of the United States Air Force. As a result, there is a pressing need for accurate methods to determine metallic concentrations in polluted water, sediment, and effluent from certain metallic processes. The technique of electrochemiluminescence (ECL) has previously shown promise in low concentration assays for organic compounds, but not extensively explored for specific use as a metal sensor. It was hypothesized that ECL could be exploited to quantify metallic concentrations using reagents that show specific enhancement for an ion of interest. Twelve organic compounds were examined for ECL activity in the presence of tripropylamine (TPA) and 34 metal ions. Of the 34 ions screened, cadmium, showed enhanced ECL activity when combined with 1,10-phenanthroline, terpyridine, and bipyridine. The ligand parameters were optimized for each ligand to encompass the effect of organic ligand concentration, TPA concentration, TPA pH, time upon signal, and mixing order. A cadmium calibration curve was compiled to examine the degree of linearity after ligand parameters were optimized for maximum signal generation for each organic compound. Interference of additional ions with cadmium were also examined and found to be problematical with ten fold amounts of interfering ions to cadmium ions, however caused smaller interference at 1 ppm levels and thought to be due to a competition effect with cadmium ions for interaction with organic ligands. The best limit of detection obtained with the optimized protocol of 1,10 -phenanthroline was found to be 9 ppb, 1 ppb below the accepted 10 ppb EPA level for cadmium in drinking water.

RAPID MODELING FOR AIRCRAFT DESIGN SYNTHESIS

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Abstract

A method for rapid structural analysis was developed and implemented within an aircraft design synthesis environment. The design environment is comprised of aircraft design objects built from an object-oriented knowledge-based modeling environment. In order to provide a useful and usable design environment, it was desirable to develop methods to rapidly evaluate and resize concepts. This paper focuses on the implementation of the structural model for the design environment. This model utilizes a parametric deformation function to relate global and local displacements.

INCORPORATING CONDENSATION INTO NASTD

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Abstract

The goal of this study is to inexpensively obtain flow conditions which ideally are suited for flow visualization

techniques involving vapor screens by incorporating condensation routines into the McDonnell Douglas NASTD

code. The analysis follows that by Ryzhov, Pirumov, and Gorbunov and results in the Fokker-Planck equation

which must be solved numerically by iteration. Further work will involve writing appropriate subroutines to

perform this task and incorporating them into NASTD which will then be used to calculate the optimal flow

conditions for flow visualization.

MOLECULAR TYPING OF *CANDIDA PARAPSILOSIS* VIA
AMPLIFIED FRAGMENT LENGHTH POLYMORPHISM
AND REPETITIVE SEQUENCE-BASED PCR

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Graduate Studies

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Abstract

Two fingerprinting techniques were used on thirty-six isolates of *Candida parapsilosis* to study their genetic

relatedness. Each organism was cultured and genomic DNA was consequentially isolated. Isolation techniques were

optimized at the University of Scranton, Scranton, PA and Armstrong Laboratories, Brooks AFB, San Antonio, TX. Two

fingerprinting methods selected, viz. repetitive sequence-based PCR and amplified fragment length polymorphism.

Repetitive sequence-based PCR results showed 33 of the 35 isolates to be identical when fragments were separated in a

agarose gel. The isolates were randomly collected from across America and were expected to show non-identical

fingerprints. Since the rep-PCR did not discriminate the strains, we decided to compare their results to an amplified

fragment polymorphism technique (AFLP). AFLP analysis was used to visualize a large number of amplified DNA

restriction fragments simultaneously. AFLP results corroborated with the rep-PCR data and placed the isolates in 3 distinct

groups. These data indicate that rep-PCR is equally sensitive to AFLP and can be utilized routinely to study genetic

relatedness in epidemiological studies.

LOW LATITUDE IONOSPHERIC TEC
MEASURED BY NASA TOPEX

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Abstract

The NASA TOPEX altimeter obtains accurate sea range measurements which require correction for the dispersive ionospheric radar signal delay. The resulting over-ocean dataset is used to demonstrate Total Electron Content (TEC) values at all longitudes. A four year period (September 1992 to April 1996) of TOPEX ionospheric data has been longitudinally binned and averaged. Software was developed and a user document was prepared to facilitate utilization of this extensive dataset. Trends in TEC variability are presented with respect to day-to-day, seasonal and longitudinal dependencies as well as the influence of solar and magnetic activity. Additional applications include verification of ionospheric models and the use of TOPEX data as a supplement to other sources of TEC. For example, vertical measurements of TEC which are determined by the TOPEX altimeter have been compared to GPS slant TEC values that are converted to vertical. These TOPEX / GPS comparisons show disagreement when satellite passes involve measurements within 20^0 to the south and to the north of the magnetic equator. The Parameterized Ionospheric Model (PIM) results of vertical / *equivalent* vertical TEC comparisons show similar patterns of discrepancy. The slant-to-vertical TEC mapping function was evaluated and modified to illustrate the effects of the ionospheric shell model assumptions.

A TEST OF THE MISATTRIBUTED-ACTIVATION HYPOTHESIS OF THE REVELATION EFFECT IN MEMORY

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Abstract

The revelation effect refers to the tendency to call an item on a recognition test "old" if a cognitive task that involves processing of a similar stimulus precedes it (Watkins & Peynircioglu, 1990). This effect occurs for both old and new test items and results in a pattern of higher hits and false alarms for items in the revelation condition. It has been proposed that the revelation effect reflects enhanced familiarity for test items in the revelation condition (Luo, 1993; Westerman & Greene, in press). A satisfactory account of the revelation effect has been elusive. The present experiment was designed to test one potential explanation for this effect, which proposes that the revelation effect reflects an increase in the familiarity of the test item due to the activation of other list items during the preceding cognitive task.

August 25, 1997
DATA SIMULATION SUPPORTING RANGE ESTIMATING FOR RESEARCH AND DEVELOPMENT ALTERNATIVES

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Abstract

Development of a range estimating methodology using neural nets was attempted this summer. Data needed to compile that would be used by the neural net to determine the sensitivity of model variables in PACES. The procedure for generating direct cost estimates consisted of definition of project and facility, selection of model type, parameter definition, and calculation of quantities ad direct cost. By utilizing these four steps and only varying the parameters of total square footage, floors above and below grade, and the building location, the direct costs varied significantly.

ALLYL AND PROPARGYL RESINS

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University of Cincinnati

Abstract

The synthesis of resins were conducted using various ratios of allyl chloride and propargyl bromide reacted with cyclopentadiene. The formulation of the resins were Allyl Cyclopentadiene (ACP), 3:1 Allyl:Propargyl Cyclopentadiene (3:1 APCP), 1:1 Allyl:Propargyl Cyclopentadiene (1:1 APCP) and Propargyl Cyclopentadiene (PCP). These hydrocarbon resins were compared to existing phenolic resins for thermal stability and mechanical properties. An examination is also given of the optimum method of fiber infiltration with the allyl and propargyl resins. This examination shows that the method of prepregging used in this study is not the method most productive for fiber impregnation. The difficulties of using this impregnation method included resin escaping from the impregnation bath, excess resin dripping from the tow as the drum turned, and prepreg with little or no tack after being removed from the drum. The later of these caused hardships in cutting the prepreg into the desired lay-up angles and an inability to lay-up the plies such that they remained in laminate form. As a result, there were no cured composites which utilized the synthesized resins.

System-Level Hardware/Software Partitioning
of Heterogeneous Embedded Systems

D'Sunte L. Wilson
Graduate Student
Laboratory for Engineering Man/Machine Systems(LEMS)
Brown University

ABSTRACT

Industry and academia today are looking for ways to design hardware and software together without the rigors of manual trial and error. Hardware/software codesign is a method in which the best solution of the hardware and software are combined to find the maximum performance of a system. Hardware/software codesign needs to meet the complexity of the design of electronic systems today with its many different heterogeneous components. In this technical paper presentation, the focus is on hardware/software partitioning. Hardware/software partitioning is a crucial aspect in any codesign method, which finds the maximum performance of an embedded system. Embedded systems are specific systems which contain hardware and software components that are particular to a certain task. The performance requirements that are evaluated are power, area, and time for an embedded system. A CAD(Computer-Aided Design) tool, named COSH, will be introduced to accomplish this mission of finding an efficient combination of hardware and software units. The results show that the theory developed through COSH finds an efficient combination of hardware and software units given various integrated circuits.

A STUDY OF THE PARTICULATE EMISSIONS OF
A WELL-STIRRED REACTOR

Max B. Trueblood
Research Assistant Professor
Melissa R. Wilson
Graduate Student
Cloud and Aerosol Sciences Laboratory

Abstract

A well-stirred reactor system was constructed and a preliminary study of its particulate emissions was made using the University of Missouri-Rolla Mobile Aerosol Sampling system. The test matrix included hydrogen and hydrocarbon fuels where the fuel to air equivalence ratios were varied between lean stoichiometric and rich. Preliminary results indicate that particulate concentrations increased by several orders of magnitude as the equivalence ratio approached 1.0 compared to those for either lean or rich regimes. The size distributions were linear in shape between particle diameters of 10 and 250nm, with the peak at the smaller diameter. Results from this preliminary study were presented at the NASA Workshop on Aerosols, Cleveland Ohio, July 29-30 1997.

CHARACTERIZATION OF SPATIAL LIGHT MODULATOR FOR APPLICATION TO REAL - TIME HOLOGRAPHY

Michael V. Wood
Department of Electrical Engineering
The Pennsylvania State University

Abstract

Spatial light modulators are used in a wide variety of applications ranging from optical computing to display. The application that is of interest for this report is that of real-time holography. A system architecture has recently been developed that uses a spatial light modulator as a real-time holographic element in a telescope system to perform adaptive optical correction of primary mirror distortions. This allows a less expensive primary mirror to be used with little or no degradation of the resulting image. The spatial light modulator is the key element to this system. This paper reports the results of an investigation of the Hamamatsu X5641 PAL-SLM parallel aligned nematic liquid crystal spatial light modulator for use as a real-time holographic element in this adaptive optics system.

A LIBRARY OF THE NATURAL FREQUENCY RESPONSES FOR CYLINDRICAL AND RECTANGULAR SHAPED PLASTIC MINES

Mark C. Worthy
Graduate Student
Department of Environmental Engineering
University of Alabama in Huntsville

Abstract

The dielectric mine problem is presented. An approximate approach for finding the natural frequencies of dielectric targets in a dielectric medium is presented. This approach is applied to (and demonstrated for) dielectric, rectangular and cylindrical cavities. A region where this approach is "accurate" is shown. A library of dielectric, rectangular and cylindrical shaped mines is presented. The library gives the name, country of origin, countries using, and electromagnetic information about 94 different plastic anti-personnel and anti-tank mines. A method for using this library to find the natural frequencies is presented and demonstrated. If this library proves effective it is suggested that the user input all of the data into software for real time (and easier) manipulation.

Simulating Transient Temperature Distributions in Optically Pumped Multilayer Laser Structures

John Yoon

Department of Electrical and Computer Engineering

University of Florida

Abstract

A numerical method for simulating the temperature distribution in an optically pumped multilayer semiconductor laser is presented in a tutorial form. The model uses the Implicit Crank-Nicolson method in a one dimensional case. The temperature distribution is calculated assuming that the power in the optical pump beam is absorbed in the active region of the laser structure. The pulse width is 0.1 ms at a duty cycle of 1%. The result of the computation is in a good agreement with that of a commercial thermal modeling tool.

DEVELOP AN EXPLOSIVE SIMULATED TESTING APPARATUS FOR IMPACT PHYSICS RESEARCH AT WRIGHT LABORATORY

Sami Zendah
Graduate Student
Mechanical & Materials Engineering
Wright State University

Abstract

The research task is intended to develop a simulated process that may be used to test different materials for resistance to failure from internal explosions. Theoretical derivations and analyses were made of the design of the test device. The equation for the stress intensity of multiple bar impact theory was evolved. The formula for reflective and transmitted stress intensity on varied areas for the impact was also derived. Three scaled down models were used to obtain pressure data in order to analyze the feasibility of the design, which will simulate the characteristics of the larger design. Various tests were conducted at Range A (Building 22B) of Wright Laboratory. An analysis was conducted in order to develop a full-scale model that will be eventually fabricated and tested.

HTML Computer Language

Kristine Angell

Camden High School

Abstract

HTML is a computer language used to create Web pages for the Internet. The HTML file is created on a word processing program, and is viewed graphically through the Internet. The HTML file consists of tag commands that create a document know as a Web page. The basic structure of an HTML file consists of the head and body. Within this structure exists a plethora of possible tags to better organize data and create style. With HTML there is also the ability to link sites together with similar information sources through the Internet.

System Administration

Michael Austin
WL/AASW

Abstract

A system administrator is the person who maintains the integrity of a computer system. He must watch over the system and make sure that the system is running smoothly. The administrator chooses what programs will be at the highest of importance. If the system grows too large, he must know how to allow it to enlarge. A system administrator is the one that fixes any problems that the system may receive from improper or unauthorized use.

A MATH MODEL OF THE FLOW CHARACTERISTICS OF
THE J4 GASEOUS NITROGEN REPRESS SYSTEMS

Karllee Barton
Coffee County Central High School

Abstract

A mathematical model of the J4 repress system was created using a modified form of Bernoulli's Theorem. The system was walked down and each component was measured. Then those units were changed into a universal coefficient which was implemented into the theorem. Using this model several graphs can be plotted. Graphs can even be plotted for different percentages the control valve is opened. In this case, flow rate duration and minimum supply pressure were plotted for set flow rates. This information is useful for the test conductor in selecting the test schedule and setting conditions at engine shutdown for cell purging and cell repressurization.

SYNTHESIS AND CHARACTERIZATION OF
MELT INTERCALATED NANOCOMPOSITES

Gaurav K. Bedi
Wayne High School

Abstract

The objective of my summer's research was to synthesize a polymer/clay nanocomposite via melt intercalation, under the direction of Captain Derrick Dean, Ph.D. and Captain Richard Vaia, Ph.D.. In order to successfully disperse the clay within the monomer, a method of sonication was utilized. This melt was then polymerized as shown by results. The interpretation of the results was accomplished using Infrared Spectroscopy, X-Ray Diffraction, and Differential Scanning Calorimetry. Two types of clays were utilized in this study. Suprisingly, experiments indicate intercalation of the polymer into the SCPx-781 Clay. However, our original hypothesis was that the polymer would not react with the SCPx-781 Clay, rather; we believed the polymer would intercalate into the Montmorilllonite Clay.

A STUDY OF THE EFFECTS OF VARYING PULSE WIDTH AND DUTY CYCLE ON POLYMER DISPERSED LIQUID CRYSTAL HOLOGRAPHIC GRATINGS

Crystal J. Bhagat
Dayton Christian High School

Abstract

The focus of this investigation was to study the effect of varying pulse width and duty cycle on polymer dispersed liquid crystal (PDLC) holographic gratings. This included four duty cycles of 10%, 25%, 50%, and 75%. The pulse widths used were 10 ms and 100 ms. The energy remained constant while the *rate* of energy deposited into the PDLC film varied. Four chopper wheels representing the duty cycles were built, PDLC syrups were formed, and grating samples with correlating duty cycle and pulse width constructed. The gratings were then written with a 514 nm laser and characterized under a 633 HeNe laser at p polarization. Switching voltage was also conducted on the ITO samples. Results from characterizing showed no trend or pattern with diffraction efficiency. A pattern was seen however with the switching voltage showing lower switching voltages for higher duty cycles. Experiments were also conducted with a pulsed nanosecond laser setup to observe the effect of nanosecond laser pulses on a grating formation. Gratings were written and samples characterized at p and s polarizations. Results showed a near linear dependence between total energy and diffraction efficiency.

Repeatability Evaluation of Night Vision Goggles for Geometric Measurements

Kimberly Blazer
Oakwood High School

Katie Lorenz
Chaminade-Julienne High School

Abstract

A repeatability evaluation of an apparatus for testing NVG geometric distortion was performed. Multiple measurements were taken in order to quantify the margin of error in the equipment and procedure. Two pairs of NVGs were tested on a rotating scan table equipped with a collimated light source, CCD camera, frame grabber, and viewing monitor. Means and 95% confidence intervals were computed for each NVG channel for measures of magnification, image rotation, and "S" distortion.

ENGINEERING ASSISTANT

Emily Blundell
Rosamond High School

Abstract

As an Engineering Assistant, I did three types of work. All involved working with

drawings. I revised two drawings for an Engineer at the Satellite Engine Operations

Complex, designed drawings for a Technical Library, and made an excel spreadsheet of

data collected from drawings at the Space Environmental Propulsion Complex.

THE EFFECTS OF INDIVIDUAL DIFFERENCES AND TEAM PROCESSES ON

TEAM MEMBER SCHEMA SIMILARITY AND TASK PERFORMANCE

Kristen R. Bonnema
High School Student
Wayne High School

Joan R. Rentsch
Associate Professor of Psychology
Department of Psychology, Wright State University

Michael D. McNeese
Research Scientist
CFHI, Armstrong Laboratory

Dawn D. Burnett
Graduate Student
Department of Psychology, Wright State University

Abstract

The research reported here examined team member schema similarity, its predictors, and its relationship to team performance. This research has implications for applied Air Force problems such as UCAV (Unmanned Combat Air Vehicle) operation, transport command centers, information warfare, battlefield management, C^3I, and joint collaborative systems such as data walls, avatars, intelligent agents, and knowledge rooms.

One purpose of the present study was to test a portion of the Team Member Schema Similarity Model with modifications. It was hypothesized that team member individual differences would predict team process variables (team interaction process variables and group process variables) and team member schema similarity (TMSS). Team process variables and TMSS were hypothesized to predict team performance.

Data were collected in a laboratory setting. Forty-five two member teams attempted to solve a complex, ill-defined problem. Team members completed individual difference measures before working on the problem. After solving the problem, team members completed teamwork schema measures. TMSS was operationalized as schema agreement and schema accuracy. Team performance and team interaction processes were coded by raters. Preliminary results are reported that indicate some support for portions of the modified model. Future research and potential applications are discussed.

H-8

DESIGN OF A SEARCHABLE
DATA RETREVING WEB BASED PAGE

Jason G. Bradford
Franklin County High School

Abstract

This summer I worked at the AEDC facility with Jason Gamble. The summer's research was focused on designing a Dynamic Database Search Engine for customers using the World Wide Web. This entailed using Hypertext Markup Language (HTML), JavaScript, a Common Gateway Interface (CGI) program written in C, and Java as tools to design and implement a web based Search Engine. The Search Engine allows the user to search a broad field of information quickly and efficiently, narrowing the options as the user selects information, and displaying the desired information in a graph. This Search Engine uses browser based languages compatible with workstations and PC's, allowing access to database information.

THE USE OF 3-DIMENSIONAL MODELING IN THE WIDESPREAD DISSEMINATION OF COMPLEX SCIENTIFIC DATA

David Brogan
Robert E. Lee High School

Abstract

A 3-Dimensional modeling program entitled "ElectroGIG" was used to create three animations. These included an eyeball, a rat brain and a radar dish. The purpose of these animations was to present recently collected data from experiments and demonstrate how the experiments were performed. Also, a UNIX-based program was used to create a wireframe model from sequential -TIFF images. Discussion includes inherent problems from working with computer animations. Also discussed were the possible uses for this technology in the future, especially in the health and medical fields.

SURFACE STRUCTURE AND OPTICAL PROPERTIES
OF A SENSITIVE SNAKE INFRARED DETECTOR

Margaret A. Bruns

Abstract

Snakes of the families Boidae and Crotalidae possess highly sensitive image-forming IR sensors used for prey detection. These natural IR sensors have several distinct advantages over artificial IR imaging systems: (1) they have the highest sensitivity known, (2) they are microscopic, (3) they do not require cooling for sensitive operation, and (4) they repair themselves. Using scanning electron microscopy and atomic force microscopy, we found that the tissue overlying the snake infrared receptor terminals has an unusual structure. This surface consists of a series of parallel plates, each of which is covered by an array of "micropits." We tested whether this surface structure may play a role in letting IR radiation through the skin by performing infrared spectroscopy on samples of tissue from the infrared-sensitive organ and from elsewhere on the snake's body. We found that the degree of pigmentation has essentially no effect on infrared transmission through the skin over the spectral range of 2-25μm. More importantly, neither pit nor eye tissue show any significant difference from body skin in infrared transmission. However, we found that the outer epidermis effectively transmits wavelengths from about 3-5μm and 8-12μm. We tested isolated intact pit organs for infrared transmission and reflection, and found that they have very low infrared reflectivity and are highly absorptive over the range of 2-15μm. These results show that the tissue overlying infrared-sensitive nerve terminals is transmissive and absorptive at both 3-5μm and 8-12μm, both atmospheric transmission windows. One of these bands, 8-12μm, includes the maximal emission, 10μm, of the snakes.

The facts that this surface structure is unique to the infrared-sensing organ and similar to that of the eye, but distinct from that elsewhere on the snake's body, suggest that it may play a role in spectral filtering Therefore, the goals of this project are to determine the surface structure of the pit organ and the optical properties that this surface imparts to the infrared-sensitive pit.

WINDOW DESIGN FOR LASER VELOCIMETER DATA AQUISITION

Shannon M. Campbell
Carroll High School

Abstract

In the project TESCOM, the airflow velocity profile at stage two needed to be measured to find out why the test had failed in the past. A silica window, along with a metal holder, was designed using mechanical engineering techniques. The obstacles to these designs were a flat window had to be placed in a circular compressor case, with the width equal to one blade pitch of stator one, and the length had to be as long as possible given the confinements of the compressor case. Two laser beams will be directed through this window and used to measure the velocity of the airflow between the second rotor and the stator, which is where the problems were in the past. However, the experiment is not complete at this time, due to a September testing date. At that time the suitability of the window designed will be determined.

HIGH SCHOOL APPRENTICE PROGRAM ACCOMPLISHMENTS

Bernardo V. Cavour
Kettering-Fairmont High School

Abstract

During the Air Force Office of Scientific Research High School Apprentice Program at Wright Laboratory, many tasks were accomplished in both sides of the computer world: The software, and hardware sides. In the software side, most of the time was spent programming an easy-to-use user interface to input and do several tasks with data into a database. The program used for the programming was Microsoft Access. The goal for the user-interface was to let unexperienced people be able to use, and take advantage of the power of Microsoft Access, without making it necessary for people to know how to program, or even use Access. On the other hand, on the hardware side, some of the tasks were: Building computers from scratch, upgrade out-of-date computers, locate and replace bad parts with good ones, and find different ways on how to approach malfunctioning computers.

Christopher R. Clark

Neural Networks an Digital Image Processing

Abstract

The areas of study presented are neural networks and digital image processing. These topics are explored using different approaches to determine their potential for use in future military sensor technology. Raw data taken from existing sensors was used to test the ability of conventional digital image processing techniques and neural networks to isolate and recognize potential targets in the input image. The process of finding a target in a scene is known as automatic target recognition.

The first task of the project involved implementing the Filtered Recursive Pulse-Coupled Neural Network in Matlab. The Pulse-Coupled Neural Network had been previously studied and it was determined that research should be continued to learn more about its features[1]. The next job was to use the Filtered Recursive Pulse-Coupled Neural Network in conjunction with fuzzy logic and a neural network classifier to develop an automatic target recognition system.

A STUDY OF PITCH AND CONTACT
ASSOCIATED WITH THE OPENING
AND CLOSING OF VOCAL CORDS

Elizabeth M. Cobb
Belmont High School

Abstract

The opening and closing of vocal cords was studied. A group of thirteen subjects, 7 women and 6 men were chosen. With the use of the Kay Elemetrics System and CSL (computerized speech lab), each subject performed six lists of fifty MRT words and ten timit sentences. The .egg program was then used to determine the statistics of the data, and Excel was used to process the data onto a spreadsheet. The researcher was then planning to graph and compare the mean contact and pitch for each person.

THE EFFECT OF HYPERBARIC OXYGENATION
ON THE MITOTIC DIVISION OF PROSTATE CANCER CELLS

Linda Cortina
Theodore Roosevelt High School

Abstract

Prostate cancer is the most commonly diagnosed malignancy behind skin cancer. It is also the second

leading cause of cancer death in U.S. men. Prostate cancer in its advanced stages is currently untreatable,

thus there is a critical need for an effective treatment. For the experiment, malignant PC-3 cells were

treated with hyperbaric oxygenation. It was hypothesized that the hyperbaric oxygen exposure will slow

the growth rate of the cancer cells by stalling mitotic division. Effects of various pressure treatments

ranging from 6 ATM to 0.32 ATM were tested. Experimental results indicated that .32 ATM was the most

effective.

**Electronic Studies of Polypyrrole Films
Grown on Semiconductor Wafers**

Aaron Davis
High School Apprentice
Fuzes Branch
Wright Laboratory Armament Directorate

Abstract

Conventional polymers have been viewed purely as insulators. Since more research and development has been targeted toward polymers, now they are considered a future source of electronic materials [1]. Polymers first developed as non-conductive hydrocarbons because they were tailored for applications which demand low cost, light weight, and flexibility. Inherently conductive polymers [2] can also exhibit these characteristics. It is foreseen that someday conductive polymers will replace conventional materials in numerous applications ranging from electronic circuits and components to power transmission lines.

Experiments were performed to form a functional hybrid polymer/semiconductor bilayer. Factors considered in the formation of a diode include the dopant parameters, substrate parameters, and corrosion. Conventional semiconductor wafer material (such as silicon or gallium arsenide) was used as substrates for polypyrrole growth. Zener diodes and Schottky diodes were made through use of semiconductor wafer material coated with lightly doped semiconducting polymer material.

TRACTION MODELS

Debbie L. Dressler

Centerville High School

ABSTRACT

The viscosity of various lubricants used in an engine, specifically for bearings, was examined to produce models for reference for each lubricant as well as examine the effects of testing conditions. Friction data was plotted as a function of pressure, temperature, engine speed, and slip and this data allows us to predict the amount of heat generated and the power lost by the mechanical components. We found that when the data was plotted as friction versus slip it formed a curve that could be modeled. After we obtained the needed constants for each curve we could predict how the lubricant would behave for different conditions. Transforming the graphs from slip (x-values) and friction (y-values) to shear strain rate and shear stress respectively produces a graph of essentially the same shape. These graphs were interpreted to develop a model to fit all traction models and help predict lubricant behaviors.

Writing World-Wide Web (WWW) Pages

Stefan Enjem

Abstract

This paper documents a Rome Laboratory summer program to research, design, implement and populate a set of Web Pages for the Intelligence Technology Branch (RL/IRAE) World Wide Web (WWW) site. It describes the design considerations and alternatives involved in creating such a site, an assessment of existing tools and utilities deemed useful for Web page authors and the implementation of RL/IRAE's Web pages. With its recommended design approach, its lessons learned, and the inclusion of pointers to other valuable sources of information, this report should serve as a useful guideline to beginning World Wide Web page authors.

MERCURY ANALYSIS BY COLD VAPOR
BY ATOMIC ABSORTION

Maria Evans
John Jay High School

Abstract

The instrument used to analyze all mercury samples is called Perkin-Elmer Flow Injection Mercury System (FIMS). PE FIMS is specifically designed to determine the concentration of mercury at the low part per billion level. The analytical technique employed is cold vapor, atomic absorption spectroscopy. All samples are digested according a standard operating procedures which were developed by the Environmental Hygiene Agency and the National Institute for Occupational Safety and Health. Sample type include water, waste water, soil sludge, industrial materials and air collected on solid sorbant material. The results of analysis are used to help safeguard the health of Air Force personnel who work with mercury containing equipment and to protect the environment from further contamination during the use of this equipment.

EXAMINATION OF THE NEAREST NEIGHBOR RULE
IN VOICE PATTERN CLASSIFICATION

Douglas M. Feldmann
Oneida High School

Abstract

Voice pattern classification is difficult especially if there are two separate voices speaking simultaneously.

it is possible to determine classes using the k-nearest neighbor method. There are different methods of determining

k-nearest neighbors. This paper with evaluates two of the methods and shows how they can be implemented.

EXPERIMENTAL VALIDATION OF THREE-DIMENSIONAL RECONSTRUCTION OF INHOMOGENEITY IMAGES IN TURBID MEDIA

Lauren Ferguson
Moriarty High School
Moriarty, New Mexico

Abstract

Near infrared radiation for imaging tumors in tissue has been recently explored and investigated. In particular, to validate a novel FFT imaging reconstruction algorithm, we have performed experiments on tissue phantoms using a frequency-domain photon migration system. The system includes an amplitude-modulated laser diode, two radio frequency (RF) signal generators, an avalanche photo detector, and a lock-in amplifier. The tissue phantoms were made with inhomogeneities imbedded and were then scanned with the system at various RF frequencies. The data from the amplitude and phase measurements were analyzed using the FFT reconstruction algorithm. The reconstructed data show clear validation of the FFT algorithm and afford to localize inhomogeneities hidden in turbid media in three dimensions. In addition, based on the results, we present preliminary analysis on optimization of experimental parameters to obtain good-quality, reconstructed images with best experimental efficiency.

THE MULTI-TEMPORAL
TRAINABLE DELAY(MTTD)
NEURAL NETWORK
ARCHITECTURE

Patrick X. Fitzgerald
Holland Patent High School

Abstract

This paper presents an analysis of the Multi-Temporal Trainable Delay Neural Network architecture. The analysis was accomplished using multiple tests of an MTTD neural network simulator with a dual layer neuron scheme. Each test was done on multiple different dual-layer networks. From the test results the capabilities of the neural network was determined. The analysis tested the abilities of the network to learn and recognize temporal patterns. During the analysis of the architecture several changes were made to increase the capabilities and accuracy of the architecture. The network was run on a UNIX Sun SPARC 20 workstation running operating system Solaris 5.5. The program code was written in ANSI standard C and compiled under the same system software.

THE STUDY OF THE ELECTRO-OPTIC
COEFFICIENTS OF DR-1 AND DANS

Matthew Gerding

Abstract

The electro-optic coefficients of several important poled polymers were measured and recorded to establish a baseline for future reference. The experiment employed allowed us to electrically pole a sample and measure the material's electro-optic coefficient. The experiment followed the basic reflection ellipsometric technique of Teng and Man[1], but with a few variations. The results of these baseline measurements will aid in the research and discovery of new polymers with the necessary characteristic of high electro-optic coefficients and sufficient thermal stability.

Chaotic Dynamics in a Nd:YAG laser

Erica S. Gerken
Manzano High School

Abstract

A diode pumped Nd:YAG laser was constructed. The pump beam was modulated in order to stimulate nonlinear dynamics. Bifurcation processes were investigated. Data was acquired using a 16 bit vertical resolution digitizer card and signal processor.

RF MODULE LIFE TEST SYSTEM DESIGN

Daniel Grabski
Holland Patent High School

Abstract

This RF module life test system is a conversion from an earlier life test system. The system life tests RF modules under heat stress for long periods of time, and records data on the module's RF output. The new system is designed to be more versatile than the earlier version through improved RF switching and reduction of unnecessary components. The new life test system was also tested for attenuation through its RF input and output channels at frequencies in the C and X bands (2 to 12 GHz).

THE FLIGHT DYNAMICS LAB

Jon M. Graham
Carroll High School

Abstract

My employment in the Flight Dynamics Lab at Wright Patterson Air Force Base did not consist of a single performed experiment on which data could be retrieved. Rather, it involved various short-term assignments and simple jobs that needed to be done. Even though I did not perform a professional experiment, as it were, the time I spent over the summer was extremely valuable. I learned a great deal about the modern workplace and also about the specific duties and projects of the Flight Dynamics Lab.

CAST DUCTILE IRON (CDI)
(A CONTROLLED FRAGMENTATION STUDY)

Trenton A. Hamilton
Rocky Bayou Christian School

Abstract

Sub-scale tests were conducted using Cast Ductile Iron (CDI) cases to control case fracture. Data was collected using Celotex collection media, velocity screens, 16 gauge steel witness panels, 10,000 fps high speed camera, and 2 lines of pressure gauges. The primary purpose of the testing was to confirm that the fragments would be of a specified, uniform size (weight). This data was reduced to determine the effectiveness of CDI over soft steel cases. The CDI cases were manufactured to yield a uniform fragment of specified size. Success of this test series will be determined from the percent of total mass recovered for each fragment weight division. Thirty percent fragment mass in the specified division would constitute a successful control of the case break-up. Although the cases did not provide the specified fragment weight distribution, results indicate the case fracture was controlled.

NEUROPSYCHOLOGICAL EXAMINATIONS FOR PILOTS

Daniel L. Hardmeyer
James Madison High School

Abstract

Neuropsychological testing is administered to UPT pilots, the normal pilot population, and certain special cases. Neuropsychological testing is a factor in the selection of pilots. When pilots are having certain problems (neurological or psychological) they are given these neuropsychological examinations. Testing is also administered under other special circumstances.

Comparison of Experimental Data with Various
Penetration Prediction Methodologies

Neil N. Harrison
Walton High School

Abstract

In this study, experimental data from tests done at the AWEF was compared to data from simulations of the

same tests using three different penetration prediction codes: PENCRV3D, LaBombA, and EPIC. Six

different cases were studied, varying only in the nose shape of the penetrator used in each case. All other

conditions of the six tests were the same. Input files were created for each test under each penetration

prediction code and the tests were run. Finally, the data received was compared to the data from the

experimental tests. The results all ranged from 81.8% to 134.5% of the experimental data. This showed

that all three methods used were satisfactory, although LaBombA and PENCRV3D showed slight

advantages.

WINDOW DESIGN FOR LASER VELOCIMETER DATA AQUISITION

Anna S. Hill
Carroll High School

Abstract

In the project TESCOM, the airflow velocity profile at stage two needed to be measured to find out why the test had failed in the past. A silica window, along with a metal holder, was designed using mechanical engineering techniques. The obstacles to these designs were a flat window had to be placed in a circular compressor case, with the width equal to one blade pitch of stator one and the length had to be as long as possible given the confinements of the compressor case. Two laser beams will be directed through this window and used to measure the velocity of the airflow between the second rotor and the stator, which is where the problems were in the past. However, the experiment is not complete at this time, due to a September testing date. At that time the suitability of the window designed will be determined.

EFFECTS OF TIMED EXPOSURE TO DIBROMOBENZENE ON ARACHIDONIC ACID LEVELS IN SKIN USING A METHYL ESTERIFICATION QUANTITATION METHOD

Nafisa Islam
Centerville High School

Abstract

The effect of exposure to dibromobenzene on arachidonic acid levels in rat and guinea pig skin was studied. In order to quantitate arachidonic acid levels by gas chromatography, the acid must be esterified. Thus, a time and temperature study was conducted first in order to optimize time and temperature conditions for methyl esterification of arachidonic acid. Afterward, guinea pigs were exposed to dibromobenzene by dermal contact. While most skin studies are conducted on bald animals, the animals used had hair. Following exposure, the skin was harvested and collected in samples. The epidermis and underlying lipid bilayer were scraped off and an extraction procedure was followed to isolate total lipid fractions, which should include arachidonic acid. The samples then underwent the methyl esterification process, after which they were analyzed by GC. Results were generally inconclusive, perhaps due to inconsistency in scraping off the epidermis.

ANTENNA PATTERN MEASUREMENTS USING INFRARED IMAGING TECHNIQUES

Sandra L. Jablonka
Oneida High School

Abstract

Antenna pattern measurements using infrared imaging techniques were studied. An infrared test setup was used in an anechoic chamber to gather the measurement data. To collect different sets of data, minor variations were made to the setup. The data was processed by Matlab visual software in order to make comparisons concerning the modifications of the test setup. As a result of the processing and analysis, the configuration for antenna measurements was optimized.

EFFECTS OF BRAIN TEMPERATURE ON FATIGUE IN RATS DUE TO MAXIMAL EXERCISE AND 2.07 GHz MICROWAVE RADIATION

Kathleen S. Kao
Keystone High School

Abstract

In previous experiments, it has been observed that fatigue in rats may be linked to hypothalamic temperatures (T_{hyp}) and that exercising rats become exhausted once the T_{hyp} has reached approximately 40.7-41.5°C. We attempted to prove the validity of this observation by subjecting a group of rats to two separate treatments, a microwave (MW) and a sham exposure, each followed by a run to exhaustion. Hypothalamic and rectal temperatures (T_{rec}) were measured continuously during their run. Each rat underwent both the microwave and the sham treatments. For the microwave treatment, the rat was placed in a Styrofoam restrainer and its T_{hyp} was heated with MW radiation up to 41.5°C. During the sham treatment, the rat was also restrained, but not exposed to any microwave radiation. There were significant differences in both pre-run T_{hyp} and T_{rec} between sham and microwave rats. However, there was no significant difference between the two treatments for either the peak T_{rec} or T_{hyp}. Although there existed no significant difference between the mean time to exhaustion of the sham and microwave groups, there was a significant difference between the heating rate and weight loss of the two groups. Because there was no significant difference between the mean peak T_{hyp}, we conclude that there exists a critical brain temperature which limits the ability to perform exercise.

FRICTION AND SOLID LUBRICANTS

Erek Kasse
Bellbrook High School

Abstract

The coefficient of friction of various ZnO films and powder composites were studied. To find the coefficient of friction for these films and powders a tribometer was used. The samples were tested at different temperatures, loads, speeds, and humidities. Experimental results indicated only one of the 6 types of films tested exhibited extremely good friction coefficients and very low rates of wear. A variety of ZnO powder composites were also tested and showed fairly good friction coefficients for short periods of time.

Assessment of Microwave Horn Antenna Radiation Pattern

Barbara E. King

AFOSR Summer High School Apprentice

Abstract

An experiment to determine the attenuation of communication signals by rocket exhaust plumes is being conducted at the AF/PL (Air Force Philips Lab). The goal of the experiment is to determine rocket exhaust plume plasma properties, which are needed to analyze the attenuation of communication signals by rocket exhaust plumes. In order to achieve this goal, plume conductivity measurements are being made using microwave diagnostics. At the AF/PL test cell, three pairs of microwave horns will be placed around the diffuser. Each pair of microwave horns will radiate a different microwave frequency. Lenses will be placed on the horns to focus the microwave beams. The electron number density will be determined by measuring the intensity of microwaves radiated and the intensity of microwaves received. Due to the small scale of the rocket motor being tested, an assessment of the microwave beam extent was required. For this assessment, amplitude and phase beam patterns have been measured. The results of these beam pattern experiments are discussed in this report.

A STUDY OF GENETIC ALGORITHMS

Colin M. Kinsella
Oneida High School

Abstract

I worked on making a simple genetic algorithm with programming in Microsoft's Visual C++ version 4.0. I tried to write the program inside a console window and as a windows application. Each presented a different means of approaching the problem, and each presented benefits as well as problems. The console window allowed me not to worry about where windows are position and the what not that comes with programming in windows, while programming in windows allowed me to edit the input going into the program.

Analyses of Metal Concentrations
By Flame Atomic Absorption Spectroscopy

Lauren M. Lamm
Keystone School

Abstract

Atomic absorption spectrometers are instruments used for identification and quantification of metal elements in a variety of different matrices. Before samples of materials in their various forms can be tested to determine the concentration of a given metal they may contain, they must first be digested by concentrated acids in order to produce an aqueous solution in which the target metal is isolated according to methods and standards set by the National Institute Of Safety and Health (NIOSH) and the Environmental Protection Agency (EPA). Because each metal has a unique electron structure capable of absorbing and emitting light energy at specific wavelengths, atomic absorption spectrometers are used to detect the metal atoms within a sample. The light energy absorbed from a hollow cathode lamp is proportional to the concentration of the metal being analyzed. At this point, the results determine whether or not the material is safe for people to work with or dispose of in a normal fashion.

ABDAR Remote Engineering

Evan Large
Northwestern High School

Abstract

The possibility of a medium to be used in long range engineering requests for Aircraft

Battle Damage Assessment and Repair was researched. Information was gathered from the

World Wide Web, Air Force personnel, and Air Force libraries. Through these research

mediums, different computer hardware and software was studied in the hopes of devising a

system capable of performing remote engineering requests. The results of this research indicated

that such a system is feasible with current technology.

THE DATABASE DESIGN FOR A
CONFIGURATION MANAGEMENT LIBRARY

Maria Lee
Wayne High School

Abstract

A database was created for an unorganized Configuration Management Library that contained documents, texts, and videos. The database tables were designed, created, and used to update all the information concerning the documents, text, and videos in the Library. The database tables were also designed to contain the descriptions of all the items (documents, texts, and videos) along with all the information needed to locate the items in the library. Forms were also designed for use with the database tables. Forms were created that allowed the user to enter new items into the database. To help physically organize the library, queries were used to sort and group the documents by status; and eventually the queries were used to put all the documents in physical order by document number or title. After the library was organized, reports were created that provided a listing of all the item in the library, along with their physical location. This database for the Configuration Management Library will enable the engineers who use the documents, texts, and videos locate and retrieve the items easily.

THE EFFECT OF CHAIN LENGTHS ON BOND ORDERS AND GEOMETRY IN SIMPLE CYANINES

Colleen LeFevre

Abstract

The main objective of this experiment is to observe the trends in various characteristics of the simple cyanines as the number of carbons is varied. Models were first made of the simple cyanines in Chem 3D, then the geometries were optimized using molecular mechanics. Finally, self consistent field (SCF) semi-emperical calculations were performed using MOPAC93. The data was organized and analyzed on spreadsheets.

Different calculations were then performed (CI and Hartree-Fock *ab initio*) in order to test the validity of the MOPAC calculations. Experimental data was also used for comparison. The calculations were in sufficient agreement to predict trends in the cyanine molecules.

It was observed that as more carbon atoms are added to the cyanine chain, the geometry becomes asymmetric and less stable, and the bond orders tend to localize in the larger chains.

Abstract

Two computer based methods for predicting the location of the center of pressure of a missile fin were studied. One was a function of fin geometry and normal force coefficient, the other was a function of fin geometry only. They were compared with data obtained on seven different fins that were tested on a body and six fins that were tested on a splitter plate. The method that was a function of fin geometry and normal force gave good or fair agreement for all 13 cases studied. The method that was a function of fin geometry gave poor agreement for eight of the 13 cases studied and good agreement for only 3 cases.

Nanoparticle Doped Organic Electronic Junction Devices

Alex Lippert
High School Apprentice
Fuzes Branch
Wright Laboratory Armament Directorate

Abstract

Scientists have recently discovered that polymers could be synthesized so that they would be conductive of electricity. The polymers could be used to make organic electronic junction devices. The goal of this project was to create an organic p-n junction. This was attempted by depositing n-type doped polypyrrole on top of p-type polypyrrole. A colloidal suspension of antimony tin oxide was used to dope the polypyrrole film n-type. These bilayer films were then tested to see id a p-n junction resulted.

THE ROLE OF MICROSOFT'S DIRECTX 3 SOFTWARE DEVELOPMENT KIT IN THE RAPID DEVELOPMENT OF HIGH FIDELITY SIMULATIONS

Shaun M. Little
Floresville High School

Abstract

The Role of the DirectX 3 SDK (Software Development Kit) in the development of high fidelity simulations was studied. Borland Delphi Developer 2.0 was used in conjunction with the DirectX 3 SDK header files and the Delphi Games Creator to form the programming environment in which the simulations were created. Careful observation of the development process indicates that the DirectX 3 SDK can significantly increase the fidelity of a simulation while decreasing the time spent in its development and maintaining a high level of experimental control over its testing environment.

A STUDY ON OPTICAL PATTERNATION

PAUL G.LOFTSGARD

Abstract

Optical patternation was studied in an attempt to create a three dimensional image of a liquid cone, created by a nozzle, of a specific angle, and composed of fluorescent water. The image is created through the use of Planar Liquid Laser-Induced Fluorescence(PLLIF). PLLIF is done by taking pictures, using CCD camera, of a laser sent through a spray containing a fluorescent dye. With the use of a fluorescent filter the camera is able to take accurate pictures of the spray and it's intensity. This type of picture is taken at successive heights and combined to form a three dimensional model of the spray.

Visual Acuity between 6 and 60 Meters

Katie Lorenz
Chaminade-Julienne High School

Kim Blazer
Oakwood High School

Abstract

Experiments were conducted in order to determine the effect of intermediate distances (between 6 and 60 meters) on visual acuity. The Landolt "C" was chosen as the target for the experiment. Acuity was measured by the minimum angular size of the gap which is just visible in the "C". Factors in the multiple experiments included different target sizes, contrasts, lighting, and orientation, as well as binocular versus monocular vision testing. All of the various factors were controlled for in individual experiments when necessary. Experimental results suggest that there are many variables to be controlled in data collection of this type and that intermediate distances do, in fact, have an unexpected affect on visual acuity. As expected, contrast, lighting, orientation affected the data, but the target size should not have affected the visible angular size of the gap. What should have been equal size to distance ratios were, instead, unequal among all of the subjects tested. As the size of the target increased, the distance did not increase according to the same ratio. Several experiments were conducted attempting to solve this occurrence, but no solution was yet found.

WEB PAGE DESIGN TO DISPLAY
INFRARED IMAGERY

Marcus MacNealy
Chaminade-Julienne High School

Abstract

Methods of displaying infrared imagery, collected for use with automatic target recognition technology, were studied. This imagery had to be coverted and placed on the internet. Allowing people access to the imagery required the development of an interface that was intuitive to use. Several designs were tried until a satisfactory one was found.

H-47

Analysis of DWSG Characterizations

Kaitrin T. Mahar

High School Apprentice

Coffee County Central High School

Abstract

Arnold Engineering Development Center's Focal Plane Array Test Chamber tests infrared focal plane arrays, important components of strategic and tactical weapons sensor systems. It simulates space-like environments and mission scenarios created by Direct Write Scene Generation. The data from this testing can be analyzed using Visual Basic programming.

Terminal Ballistics Data Acquisition and Analysis

David Mandel
Niceville High School

Abstract

In this project the goal was to create a database for a large bore, high velocity launcher so that a base data set could be available for any further testing which may be done with this particular gun. The gun used was a 127mm cannon removed from a tank with an extra barrel added. Several shots were fired varying the projectile mass and make up, the armor type and thickness, the powder charge, the launch package mass, and other minor parameters. The shots were then fired and essential data was recovered such as barrel recoil, penetrator velocity, and even X-ray photographs were taken. All essential data was then entered into the computer for processing. Now when any further testing utilizes this launcher, the engineers have a database to look at when determining the parameters for their shot.

THE MECHANICAL AND METALLURGICAL CHARACTERIZATION OF LIQUID PHASE SINTERED TUNGSTEN ALLOYS

Michele Viola Manuel
Crestview High School

Abstract

Hard Target Weapon (HTW) penetrators to date have been produced from high strength low alloy steels. Although these penetrator materials have performed well against their targets, newer, more deeply buried targets require improved penetrator materials. Two tungsten alloys were evaluated for their mechanical and metallurgical properties for potential application as HTW penetrator materials. The two alloys were (1): 92.1 W, 4.97 Ni, 1.48 Co, 1.47 Fe; (2): 90.1 W, 6.1 Ni, 1.8 Co, 1.8 Fe. Tensile tests (both High Rate Instron and Split Hopkinson) confirmed a strain rate dependency, significance of tungsten particle contiguity, and indicated some differences in strength and toughness between the two materials.

WRITING A COST ESTIMATE PROGRAM USING THE JAVA PROGRAMMING LANGUAGE

Steven W. Marlowe

Abstract

The Aircraft Systems Department of Arnold Engineering Development Center has seen a need for a quick, efficient, and easily accessible cost estimation process. To fill this need members have hypothesized about the writing of a computer program to receive specific information about a test and convert it into an accurate estimate of the cost for such a test. An application to estimate the programming hours required for a specific test was written for the Data Support Team, a smaller entity of the Aircraft Systems Department. This program was written using the Java programming language. The use of Java for this project enabled any computer on the network using a standard browser to access the program and quickly estimate the cost for a specific test. Based on this program for the Data Support Team, the decision was made to develop a similar program for the Aircraft Systems Department using Java.

A Study of Chemical Vapor Deposition And Pulse Laser Deposition

Lori M. Marshall
Carroll High School

Abstract

The three basic topics studied over the course of this internship were building and designing circuits, programming in C code, and Raman Spectroscopy. All of these topics were studied in conjunction with Chemical Vapor Deposition equipment that continuously coated sapphire fibers and Pulse Laser Deposition that creates high temperature superconducting films. A circuit was designed which became a part of the processing equipment to make operation more convenient for the operator. Programming in C code was used to program a stepper motor for use in winding the coated fibers onto a spool at a constant angular velocity. Additionally, Raman Spectroscopy was studied as a potential sensor for use inside a coating process to yield information about the coating properties.

EXPERIENCE AT THE AIRCRAFT SURVIVABILITY ENHANCEMENT BRANCH AT WRIGHT-PATTERSON AIR FORCE BASE

Terrence J. McGregor

High School Apprentice

Aircraft Survivability Enhancement Branch

Wright-Patterson Air Force Base

Abstract

The project I was assigned to for the summer was a Chain Armor Ballistic Test. The objective of the test was to establish the ballistic limit of the chain armor. Before the chain armor was shot I also shot ½" and ¼" steel to establish their V_{50}. As the test engineer for the project, I supervised the fabrication of essential parts, and the preparation of the test articles. After the testing was completed, I was charged with evaluating the data and processing the data into a final report under the supervision of Mr. Alex G. Kurtz (WL/FIVSA). Following, is the Test Plan and Final Report for the project minus pictures.

A Study of
Accuracy and Response Time in Tests
of Spatial Ability

Mark T. Meiners
Dobson High School

Abstract

Mental rotation is the ability to see three dimensional objects in space and then mentally determine the characteristics of each object. The effect of mental rotation in depth is quite different from the effect found with mental rotation in the picture plane. The angular difference in depth for comparisons of same or mirrored objects was thought to predict the mean response times. An effect called the tandem rotation effect is a counterexample to that hypothesis. Two shapes are separated by an angular difference in depth, then tilted in depth. There is an almost linear variation between the mean response times and the amount of yoked rotation when angular difference is held constant. The tandem effect supports the idea that the mean response time is a function of the area shown to be rotated away from the picture plane; not as a function of the angular difference between the two objects. Tests were done to determine whether or not the area shown on screen has a part in response times. Varying speeds and tilts were incorporated with the angular difference to determine what was playing the key role in response times. After all the tests were done, the data was collected, summed into large databases, and then roughly analyzed with graphs.

A STUDY OF HOSTILE ELECTROMAGNETIC ENVIRONMENTS WITHIN MULTICHIP MODULES

Matthew A. Miling
Vernon-Verona-Sherrill High School

Abstract

Hostile environments within multichip modules were studied. The study emphasized how electromagnetic wave propagation occurs when signals traveling along a microstrip line reach a bend or, in this case, a via. The patterns of phase and amplitude were studied at probes inserted within the microstrip simulation. The Finite Difference Time Domain Method (FDTD) was used to accurately characterize the propagating energy traveling throughout the module. Future work will involve the program we developed to investigate a microelectromechanical system (MEMS) device.

AN ANALYSIS OF RADIOFREQUENCY RADIATION-INDUCED TEMPERATURE GRADIENTS IN THE RAT BRAIN

David J. Miller
Texas Academy of Mathematics and Science

Abstract

Microwaves are a form of electromagnetic radiation that can cause thermal damage to objects exposed to them. High powered microwaves (HPM) have the capability to cause massive thermal damage to an individual exposed to them. Micrwaves are particularly dangerous, because they do not heat uniformly. At the present time, doctors do not realy know what organs are in great danger of being damaged during HPM exposure. The hope is to create a model of a whole human being after creating a model of a rat brain and head. Five mathematical models of increasing complexity have been created that mimic the exposure of a rat head or brain to HPM. The five models are the spherical; cylindrical; homogeneous cylindrical; cylindrical shells; and whole-head, non-homogeneous cylindrical shells models. The results of these models are then discussed and compared to real experimental results.

A STUDY OF

SPACE STRUCTURE'S

ISOLATION

Fawn R. Miller

Manzano High School

Abstract

Tests on the Taurus-2 mass-payload for the GFO Mission were completed. The tests utilized a 45,000 lb. shaker to provide controlled base motion. The first test was run without any isolation techniques, and then isolators designed by CSA Engineering were installed, and the test was run again. The isolators damp the satellite vibration during launch. These tests were performed to demonstrate the system performance under launch-like conditions.

A STUDY OF THE EFFECT OF FUEL SULFUR CONTENT
ON THE PRODUCTION OF AIRCRAFT EXHAUST PLUMES

Amy W. Mok
Newton North High School

Abstract

In an attempt to discover the effect of fuel sulfur content on the production of contrail, several flights were conducted in which F-16 aircraft burned different types of sulfur fuels. A T39 collected and studied samples of the contrail and separated the sample with use of a mass spectrometer. This instrument revealed what was contained in the sample and how much of each was present. The results indicated that amounts of each of the masses did change due to the variation of the fuel sulfur content. More in-depth studies were necessary to prove and explain the differences.

Studies in Computational Chemistry and Biomimetics

Ryan M. Moore
Centerville High School

Abstract

The main focus of my studies was to study mechanical properties of polymers. I calculated the mechanical properties by use of the semi-empirical program MOPAC, and have also had to learn UNIX, Cerius2, Quanta, Biosym, ChemDraw and Chem 3D. Cerius2 was used in the construction of the molecule and in setting up the MOPAC process. MOPAC93 was mainly used in the computational investigation to determine the heat of formation with straining the molecule and evaluate the modulus. The other focus of my studies was based on a snake project. Snakes have so-called "pits" near the front of their mouth. These pits and other organs of the body are being used to determine how snakes use their infrared sight and how this understanding can mimic devices of interest.

THE SEPARATIONS AND REACTIONS OF CYCLOHEXYL POSS COMPOUNDS

Martin Morales
Palmdale High School

Abstract

Cyclohexyl POSS compounds are very useful in polymer chemistry. The collection and separation are vital steps taken in order to apply these compounds to rocket propulsion systems. The collection of cyclohexyl Poss compounds is long and tedious. The separation requires large amounts of solvent. Therefore, new methods for decreasing the amount of starting material were studied. Once isolated, functionality was added to them through corner capping reactions.

CONSTRUCTION OF A GRAPHICAL USER INTERFACE
FOR THE THERMALLY PERFECT GAS CODE

Michael R. Munn
University of Notre Dame

Acknowledgements

CONSTRUCTION OF A GRAPHICAL USER INTERFACE
FOR THE THERMALLY PERFECT GAS CODE

Michael R. Munn
University of Notre Dame

Acknowledgements

METHODOLOGY FOR THE CREATION OF A RANDOMIZED SHOT-LINE GENERATOR

John D. Murchison
Ft. Walton Beach High School

Abstract

Historically the assessment of target kill was a simple matter of observing whether a crater existed where a target once was. In contrast the smaller, higher precision munitions of today do not produce such obvious evidence of target kill. Therefore a more analytical approach to the assessment of target kill is required. Using lethality assessment codes, lethality experts have been able to predict overall target damage. Although these lethality assessment codes are competent indicators of inflicted structural damage, they are deficient in their ability to generate reliable component damage predictions. To correct this shortcoming component fragility data is being collected upon a variety of components, these include; transformers, fluid circuit breakers, pumps, generators, etc, which might be found in targets of interest. One type of fragility testing consists of impacting steel cubes into a desired component along a random shot-line. The damage incurred by the component is recorded as its fragility data. This is the type of testing discussed within this paper.

Shot-lines used in the testing of component fragility may be created using computer programs. The requirements of such a program stipulate that it must be able to generate both the location and angle at which a cube strikes the component. The methodology of the creation of such a program necessitate the inclusion of a uniformly distributed random number generator, and the derivation of algorithms which properly weight the occurrence of impact locations and angles in accordance with real conditions.

AN INVESTIGATION OF
THE PRECISION OF THE EL-MAR
FIXATION ANALYSIS SOFTWARE TECHNOLOGY

Shannon J. Murphy
Keystone School

Abstract

The *el-mar* Fixation Analysis Software Technology(FAST) analyzes eye movements. Because FAST was built to support instructional applications, such as training novice pilots, the precision of FAST for detailed analysis has not been documented. I investigated to what extent the precision of FAST can be taken to be used in scientific research. The precision of FAST was investigated through a series of three data collection and analysis experiments performed on an eye scan instruction tape prerecorded with the Vision 2000 system. The first experiment was to determine the precision at which one file of collected data could be reanalyzed. The second experiment was to determine which system of restart data collection yielded the most precise numerical data. The third experiment was to determine the method of using the correct end field at which a specific length of the instruction tape could be recollected as data and analyzed with the most precision. Given the same data colection file and object table, experiment 1 proved that the actual analysis step of FAST will consistantly produce the same results (ie. 100% precision) and therefore any variability in the numerical data is due to data collection. The results from experiment 2 suggested that the variability in numerical data is not significantly effected by the restart system used in data collection. The results from experiment 3 suggested that the variability in numerical data continues with the minimization of human error. Therefore several replications of results are reccomented when performing a detailed analysis.

INTRANET DEVELOPMENT PROBLEMS WITH POWERPOINT

Jason A. Myers
Coffee County Central High School

Abstract

Intranet development presents many problems, and one of the most common is the need for an effective

way to incorporate presentations into web pages. All currently available methods have many drawbacks.

The only way to determine which is the most effective in your situation is to test and use many different

products and methods of incorporation. The one that is easiest to use and provides adequate results is the

best way to incorporate the presentations. However, there is not definite way that to accomplish this task.

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METALS ANALYSIS BY ATOMIC ABSORPTION
USING A GRAPHITE FURNACE

Katrina Navalta
Northside Health Careers High School

Abstract

Atomic absorption spectrophotometry has become a method for chemical analysis of trace metals at the parts per billion level in solution. It is a useful and popular technique because it can be applied to many different fields of science: agriculture, biochemistry, the environment, food products, forensic chemistry, geochemistry, industrial analyses, metallurgy, petrochemistry, pharmaceuticals, cosmetics, plastics, and fibers. The modern technology of the graphite furnace dates from about 1980 yet it has developed with tremendous speed into becoming the most widely used method for determining metals at ultratrace levels in biological materials. The Perkin-Elmer 5100 PC Furnace Atomic Absorption Spectrophotometer is used to analyze metal elements in air and bulk samples with very low detection limits and small volumes. This is a machine with great versatility and is fully automated. The metals analyzed by this instrument are: arsenic, antimony, cadmium, lead, selenium, thallium, and tin. Before analysis, there is a certain way to digest each type of sample received. Each includes the addition of nitric acid to break down the sample and concentrate it into an assigned final volume. This concentrates the sample so the condensed volume will be free of solids and the whole sample can be analyzed at an amount of 20 microliters but still representing the whole sample. Many considerations are made before each run, including parameters for the analyte and background interferences, but overall, this is a field on analytical chemistry that will continue to develop into faster and more convenient ways for the detection of metal elements in solutions. I digested a lot of samples (ex. dirts, paint chips, sludges, gauze swipes, air filters, hazardous waste) in a laboratory setting over the hot plate or through microwave digestion. There was no experimental research involved, we had set guidelines to follow for digestion and operation of the instruments for an analysis of a sample.

SPINNING A WEB

Christine P. Pan
Health Careers High School

Abstract

With over 30 million Web pages online and more being launched each day, Internet users can easily be overwhelmed by the tremendous amount of information available. To entice and maintain an audience, institutions must make sure their Web sites are navigable, useful, and attractive. This means that before creating any Web documents, developers must outline goals and formulate a general information architecture. A well structured content is instrumental in producing a successful Web site. HTML coding of the first draft design should be followed by several rounds of design reviews and revisions. In addition, user testing enables the identification of any potentially confusing areas. Only after the material has been fully developed and tested should the Web site be made available to the general public. This paper documents how this product development cycle was used to create a Web site for the Armstrong Laboratory Cognitive Task Analysis group.

INTRANET WEB PAGE,
DESIGN AND DEVELOPMENT

David D. Parker
Boron High School

Abstract

We attempted to create an attractive Intranet Web Page for Phillips lab through the process of trial and error as we attempted to use different forms of web page creating techniques. In the past few years there has been a drastic increase in the use of the Internet. This increase of usage has resulted in many new uses that often times include household and business uses that normally would not be considered in everyday discussions. On the business aspect, there are ways to create an intricate web page system for a business that is only available to that business. Other businesses can also receive permission to access the system by the operating center. The use of this type of business owned Internet system is often times referred to as Intranets. With this new capability of using Intranets, a business is able to communicate and broadcast all forms of information to their employees via a network system. This ability makes it possible for the businesses to save money on costs that would normally originate from memos and other forms of communication that is now much less economically sound..

Empirical Characterization of Mid-Infrared Photodetectors
for a Dual-Wavelength LADAR System

Neill W. Perry
Crestview High School

Abstract

Spectral measurements were conducted on silicon (Si) and germanium (Ge) avalanche photodetectors. Detector characterization was computer automated using LabVIEW, a graphical programming language. The collected data provides the information necessary to design individual receiver circuits for both of the specific devices, enabling either to be incorporated into a dual-wavelength laser radar (LADAR) system.

COMPUTER MANIPULATION OF RAMAN SPECTROSCOPY TEST DATA
BY
JAMES PERRYMAN

ABSTRACT

Aerodynamics, the study of fluids and their resultant forces, has experienced significant

advancements in the past twenty years. Yet, there is still much left to uncover. Computational

Fluid Dynamics(CFD) attempts to logically determine the fluid properties of a model for given

flow conditions. The advantages of this technique are the huge savings in time and money over a

traditional tunnel based test system. No equipment is required, because the flow is calculated

and simulated with mathematics on a computer. CFD has the potential to greatly enhance

aerodynamics testing, enabling man-hours to be spent investigating new frontiers. CFD's success

depends on the accurate modeling of even the most minute flow characteristics. Since CFD is

only an estimation, the need for concrete, precise CFD solutions was recognized early on. The

project focuses on this data acquired from tests initiated many years ago. These tests eventually

included two models, a zero base and a broad base, each with an air-jet test, a hydrogen-jet test,

and a combustion-jet test. During these tests, various optical techniques were applied such as

LDV, LIF/Raman spectroscopy, vaporscreen, shadowgraph, interferogram, Schlieren, etc.

EVALUATION OF ARC HEATER
PERFORMANCE AND OPERATIONAL STABILITY

Kristin A. Pierce
Coffee County Central High School

ABSTRACT

Because of the requirement for high pressure segmented arc heaters with a larger testing capacity, operational characteristics over a wide range of variables must be understood. There is a need to expand the range of this knowledge in order to understand arc heater operations and to assist in the design of future arc heaters. This information can be expanded by using data correlations, comparing module wall heat flux profiles, and establishing operational stability criteria for existing and future high enthalpy segmented arc heaters. By using large nozzle throat diameter data in data correlations, the range of information is extended, and existing information is improved. The comparison of module wall heat flux profiles provides insights into the effect of various test conditions on heater operation; a larger throat size dramatically increases the module wall heat flux in the downstream portion of the heater. Operational stability limits and acceptable guidelines are now available for large throat diameter runs.

THE IMPLICATIONS OF PHOTOMODELER ON
THE GENERATION OF 3D MODELS

Kathleen Pirog
Niceville High School

Abstract

Computer models are used in many ways, especially in automatic target recognition algorithms. Therefore, it is important to be able to quickly and accurately generate three-dimensional (3D) models for these purposes. The existing method was very time-consuming, so another method needed to be found. PhotoModeler, a program developed by Eos Systems, Inc., was explored for this purpose. PhotoModeler, a photograph-based modeling program, builds three-dimensional wireframe models from light-ray equations, camera information, and marked points. Results indicated that PhotoModeler models could be generated more quickly and easily than models generated with the previous method, without sacrificing accuracy. Some difficulties were encountered with memory limitations and scaling errors. A series of tips and observations were advanced based on the PhotoModeler modeling experience.

THE WORLDWIDE WEB AND
HYPER TEXT MARKUP LANGUAGE

Nathan A. Power
Avionics Directorate
Heritage Christian School

Abstract

I created back to back web pages all summer and found new ways of presenting the information for the user by using image maps, frames, and more. My mentor, Lonnie McCray, not only guided me along the way but also challenged me in some areas that I thought I was weak in. But by the end of the summer, it showed in my work that I mastered these areas. By adding onto what I already knew, I learned very quickly how to create very powerful web pages. I also learned basic Java, JavaScript, and VRML (Virtual Reality Modeling Language). I used all of these languages in building successful web pages which, in turn, led to a successful summer.

WEB INTERFACE DEVELOPMENT

Shaun Power
Heritage Christian High School

Abstract

The World Wide Web today is a vast information resource with enormous potential to help us do our work better. Finding and using needed information from the web however can be problematical. The Avionics Directorate of Wright Laboratory has a great deal of information that it would like to share with not only the public but also the research and development community as well as the user communities. The key to effectively using the World Wide Web to perform this function is organizing, managing and presenting the huge amount of information in a easy to find, easy to use format. The benefits of sharing information include reducing the amount of repeated work done by geographically separated organizations as well as greatly improving the involvement of a diverse community in the development of a product. This improves the chances that the product will be what the end user needs and not what the developer thinks the end user needs.

Initial Experimental
Evaluation of an
Axial Groove Heat Pipe
for Aircraft Applications

Stephanie M. Puterbaugh
Beavercreek High School

Abstract

The performance and efficiency of an axial groove heat pipe to be used in aircraft applications was studied. An axial groove heat pipe was mounted onto a centrifuge table in order to observe the effects of acceleration and heat. The purpose of the experiment was to determine the operational characteristics of an axial grooved heat pipe. The heat pipe withstood heat loads of up to 15 Watts, with dry out occurring at 20 Watts.

IMMERSION CORROSION TESTING OF
TUNGSTEN HEAVY-METAL ALLOYS

Kristan Raymond
Walton High School

Abstract

Wright Armament Directorate is considering the use of high-density tungsten alloys in kinetic energy penetrators and other munitions as a possible alternative to depleted uranium. Recently, some tungsten alloys were found to readily corrode under humid conditions. The discovery raised concerns about the ability of tungsten alloys to withstand long-term storage and the possible environmental effects of alloy corrosion in test environments. Until now, the corrosion of tungsten alloys was not seen as a problem. This experiment deals with the behavior of two liquid-sintered tungsten alloys in immersion corrosion tests.

One of the alloys (HD-17) contains significant amounts of tungsten, nickel, and copper, and the other alloy (WL-1) contains significant amounts of tungsten, nickel, and iron. Nine specimens of each of the two alloys were immersed for one year in various solutions. The nine solutions include: solutions with pH's of 2, 4, 7, 9, and 12; stream water; gulf (ocean) water; and two sea salt solutions with concentrations of 2.5% and 5% salt. The solutions were analyzed periodically for the presence of dissolved metals. Observation of corrosion products and mass loss analysis of the specimens were performed on Day 365 of the test.

The HD-17 alloy samples dissolved more tungsten into solution than the WL-1 alloy. The samples of both alloys in the pH 12 and pH 9 solutions dissolved more of the tungsten grain phase and less of the matrix metals into solution than the other samples of that alloy. The samples of both alloys in the pH 2 and pH 4 solutions dissolved high of matrix metals and low amounts of tungsten into solution.

The HD-17 samples had higher corrosion rates than the WL-1 samples; when exposed to salt water, the corrosion rates of both alloy were similar. The highest corrosion rate was 0.52 mils per year (HD-17 pH 4) and the lowest rate was 0.05 mils per year (WL-1 stream water). The corrosion rates are acceptable, but extensive pitting in the matrix phase of both alloys indicates possible loss of strength and ductility not indicated by the corrosion rate.

The HD-17 (copper-containing) alloy dissolved more of its main tungsten grain phase into solution than the WL-1 alloy samples did. The HD-17 alloy also had higher corrosion rates. The copper included in the matrix phase of the HD-17 alloy probably contributed to its poor corrosion resistance.

A Study Of The Methodology Used In An Experiment Testing The Effect Of Localizing Auditory Signals On The Subject's Ability To Track Information

Anitha Reddy
The Miami Valley School

Abstract

A study addressing the influence of localization on a subject's ability to detect, identify, and monitor several auditory signals simultaneously was begun. Four men and four women were used to make the initial recordings, short phrases including standard military call signs. This paper documents the methodology used to make these recordings, which would eventually be localized and used in the experiment. It also details some of the initial processing the recordings underwent to control for irrelevant variables such as amplitude and length before the recordings were localized.

STUDY OF FACTORS INFLUENCING INJURY POTENTIAL ASSOCIATED WITH EMERGENCY EGRESS

Kavitha K. Reddy
The Miami Valley School

Abstract

The injury potential of crewmember populations possessing the greatest risk was established and assessed. Factors influencing injury potential were sex, age, and weight. Those populations which demonstrated the greatest injury potential were females, crewmembers above age 20 (risk increases with age), and lower-weight crewmembers.

A STUDY OF THE SHIFTS IN SCENE PERCEPTION MEMORY

Esther I. Resendiz
W.H. Taft High School

Abstract

In order to explain the phenomenon of vertical shifts in scene perception memory (Resendiz), an experiment was conducted to study the perspective shifts and compression of objects. Two reasons were hypothesized to cause this vertical shift: there could be a shift in the memory of objects from space close by into more distant space or there could be an elevation of the head to a default position in memory. Six scenes with a central point of interest were photographed, each from 0°, 30°, and 60° viewpoints. Thirty subjects viewed a photograph of each scene at various angles for fifteen seconds each. The subjects were then immediately allowed two minutes and fifteen seconds to redraw the pictures exactly as they remembered them. The following measurements were then made on the drawings: the compression of the objects, the vertical shift in the points of interest, and the shift in certain perspective angles. All of the drawings showed similar object compression and, additionally, the drawings of 0° and 30° scenes demonstrated a downward vertical shift. Generally, subjects tended to adjust their perspective to a default head position; thus, the objects drawn reflected the normal viewing angle at which one would see the objects in the picture.

VERIFICATION OF THE STATE OF CHEMICAL EQUATIONS AND THE GENERATION OF TEXTURES FOR PHENOMENOLOGY MODELING

David S. Revill
Choctawhatchee High School

Abstract

The first task in the project was to create a program which would be able to determine whether or not a chemical equation was balanced. This first task was performed primarily for the purpose of gaining knowledge of the programming language and capabilities of the C. In an effort to increase portability, the program was written in ANSI C.

The second task of the project was to generate textures for phenomenology modeling using Irma software. Irma software, created by Nichols Research Corporation of Shalimar, FL, models various scenes as they would be seen using either a passive infrared sensor, passive millimeter wave sensor, active millimeter wave sensor, or a Laser Radar (LADAR) sensor. The ability to generate these images provides an inexpensive way for the testing of sensors used in state of the art seeker systems. To generate the physical pieces of the image, (thus not including all of the data that goes along with every object incorporated into a scene, i.e. weather, temperature, reflectance properties, location, etc.) Irma uses facets and textures. Since it would be nonsensical to make a facet for every blade of grass, textures are used to simulate grass, sand, cement, or whatever the surface may be. In this project, texture files for grass, sand, and water were generated.

SCIENTIFIC VISUALIZATION METHODS
AT THE
CENTER FOR PLASMA THEORY AND COMPUTATION

Kimberly Robinson
Sandia Preparatory School

Abstract

Work in the field of scientific visualization allows computationalists to provide much depended upon support to experimentalists. Within this field, the World Wide Web and various graphics programs can be valuable tools for sharing information. The web enables computationalists to simulate a situation and put graphical representations of the results on a page that can be restricted by IP address or server domain, so that the experimentalist can see it the next day, without fear for security. This increases efficiency and gives experimentalists a tool by which to judge their results. As a demonstration, the results (charged particle positions and electromagnetic field values) of a Particle-In-Cell code simulation of a High Power Microwave device have been presented in the form of QuickTime animation. This animation was then placed within an outline set of web pages for the Center for Plasma Theory and Computation at the Air Force Research Lab. The individual frames of the animation were prepared with the Visualization Edition of Applications Visualization System/Express (AVS/Express).

A STUDY OF THE CAPABILITIES OF COMPUTATIONAL FLUID DYNAMICS TECHNOLOGY TO SIMULATE THE FLIGHT PERFORMANCE OF A CRUCIFORM WING-BODY AT SUPERSONIC SPEEDS

Harris T. Schneiderman
The Miami Valley School

Abstract

The performance of a cruciform wing-body missile at supersonic speeds was studied from wind tunnel data obtained in a previous experiment. A structured grid was generated around a computerized model of the missile's geometry and then analyzed using the General Aerodynamics Simulation Program (GASP). Both tests were given the objective of determining the coefficient of pressure (Cp) at various axial positions along the missile body. The results of each test were compared to determine the amount to which they agree. Experimental results indicate that readings for coefficients of pressure obtained in a wind tunnel can be effectively simulated strictly by a computer that utilizes computational fluid dynamics equations and techniques. Thus, computer simulation can be a viable alternative to wind tunnel testing for generating accurate and reliable performance data for a flying body.

A STUDY OF THE EFFECT OF HEAT FLOW ON THE PERFORMANCE
OF AN ALKALI METAL THERMAL-to-ELECTRIC CONVERTER

Michael P. Schoenfeld
New Mexico Military Institute

Abstract

The concentration of heat flow into an Alkali Metal Thermal-to-Electric Converter (AMTEC) was studied

to determine if the efficiency of the Thermally Regenerative Electrochemical System (TRES) would increase when

heat flow is concentrated into the Beta-Alumina Solid Electrolyte (BASE) tubes and evaporator by insulation

techniques. Two experimental insulation techniques were used to see which one could direct and use the heat in the

most efficient manner. Min-K was used as a standard insulator. Two experimental insulations, alumina powder and

multi-layer foil, were used in two different set ups in conjunction with the Min-K. Based on results, it was

hypothesized that alumina powder tended to sinter, thus increasing its thermal-conductivity which allows a larger

fraction of the heat to move through the powder instead of into the cell top. The multi-layer foil was found to direct

a larger fraction of the heat into the top, reducing the amount of heat lost by conduction through the alumina

powder.

MULTI-PARADIGMATIC PROGRAMMING:
INTEGRATING PROLOG AND VISUAL BASIC

Roshan Pradip Shah
Dartmouth College

Abstract

The use of multiple programming languages, from different programming paradigms, to cooperate on a common problem was implemented. Two separate programs were created; each profited from both Visual Basic 4.0's interface capabilities and Amzi! Prolog's logic processing. The first, WordGenius 1.0, is a flash-card program intended for vocabulary building. A random word and three not-so-random definitions are selected from the dictionary database, WordNet, using Prolog and then displayed in a Windows interface using Visual Basic. The second program, PaperCutter 1.0, computes the optimal layout for partitioning 2-dimensional space. Similar to the first, the layout is determined using Prolog and the result is displayed using Visual Basic. The use of multiple languages from different paradigms to create these programs proved to be efficient and versatile.

A STUDY OF THE ANALYSIS OF URINARY BENZODIAZEPINES USING ENZYME HYDROLYSIS

Rachel A. Sharp
William Howard Taft High School

Abstract

An alternative procedure to acid hydrolysis for extracting benzophenones was investigated in order to achieve greater ease and accuracy during identification. A solid phase extraction and GC-MS confirmation method was used. Samples were hydrolyzed with β-glucuronidase at 37°C, extracted with Bond Elut Certify ® columns, and dried. Sample preparation time averaged 1 to 1 1/2 hours. Using this procedure, we are able to more accurately report the benzodiazepine most likely ingested by the patient.

A STUDY OF THE CHARACTERIZATION OF REDUCED TOXICITY MONOPROPELLANTS

Abstract

Selected characteristics of RK-124A. RK-124B and HAN-based monopropellants were investigated. Literature data on safety precautions and effects of hydrazine along with the different monopropellants were collected before the laboratory work was begun. Each liquid monopropellant was characterized including their kinematic viscosity in relation to temperature. performance (Isp. Density, Combustion Temperature). density at four different temperatures. Department of Transportation (DOT) Thermal Stability. and heat capacity. All observations were recorded in the duration of an eight week period. A desktop computer was used to calculate the theoretical performance and the Isp, Density, and Combustion Temperature were recorded. A viscosity and density measurement was made for each sample at 0^0C. 20^0C. 25^0C. and 40^0 C, and the resulting calculations were recorded and graphed. However, RK-124A was not evaluated at 0^0 because of its melting limitations but it was used in the thermal stability test. In the DSC Heat Capacity test all monopropellants produced accurate results. Unstabilized NASA HAN was made to help in comparison with the newly developed stabilized HAN. and was included in all safety and performance tests. The goal of the experiment was to evaluate the physical properties of the four monopropellants and to test their capabilities as a possible substitute to hydrazine in the future.

ABDR: Remote Engineering Requests

Curtis J. Sparks
Nazarene Christian High School

Abstract

Remote engineering requests were studied for the purposes of solidifying a new system for these procedures in Aircraft Battle Damage and Repair. Computer communications were envisioned for this system, and that is where the demonstration system went this summer for us as high school apprentices. The demonstration system for remote engineering request utilized computer conferencing software aided by various other software and hardware applications such as annotation software, e-mail, and Netscape Navigator, amongst other programs. An instruction process was given to follow between the assessor of the damaged aircraft and the engineer who is trying to be contacted remotely by the assessor. Our team project made a demonstration of remote communication between assessors of aircraft battle damage and engineers capable of fixing abnormal repair.

DEVELOPMENT AND APPLICATION OF MATERIALS CHARACTERIZATION WEB SITE

Nicole L. Speelman
Walter E. Stebbins High School

Abstract

The Internet has proven to be a valuable tool not only for research purposes but also as a way to obtain everyday information. Having access to the Internet is one of the quickest ways to acquire facts about a vast number of topics. Because of this, a materials characterization Web site was designed for those scientists and students and others interested in understanding the different techniques of materials characterization. At the Materials Lab, the need for a designated site to bring together all knowledge at hand on this topic was vital. This Web site utilized many of the Web pages already available on those subjects dealing with materials characterization. The site was established by applying the fundamental concepts of hypertext markup language and used a Web browser to actually show the layout of those pages.

ALTERNATIVE TRAINING AGENTS
LABORATORY-SCALE WORK

Lauren M. Spencer
Rutherford High School

Abstract

The overall objective of this effort is to develop one or more clean, low-toxicity chemical agents with decreased stratospheric ozone depletion potentials, also referred to as ODPs, to replace Halon 1211 in firefighter training. This report describes laboratory-scale tests, mostly cup burners, of candidate alternate firefighter training agents that have acceptable predicted toxicity's, ODPs, physical properties, and availability. Fire extinguishment test methodologies and results obtained from the testing of existing halons and potential stimulant training agents are summarized and documented.

A STUDY OF ACCURACY AND RESPONSE
TIME IN TESTS OF SPATIAL ABILITY

Tyler W. Standage
Gilbert High School

Abstract

An experiment designed to test spatial abilities of human observers was produced at Armstrong Labs. The experiments consisted of rotating decahedrons. The experiment was timed. The experiment placed certain variables on the subject throughout the different experiments, including angular difference, speed of rotation, and tilt angle. No results have as yet been formulated. Data will be used for the future enhancement of training. The experiment evaluated accuracy and the time required for subjects to make geometric judgments.

A STUDY OF THE INTERRELATION OF CLOUD THICKNESS
AND CLOUD LIQUID WATER CONTENT IN MARITIME STRATOCUMULUS

Carl W. Steinbach
Lincoln-Sudbury Regional High School

Abstract

A statistics software package was used to evaluate data collected from a vertically pointing millimeter-wave cloud radar and from a vertically pointing two-channel microwave radiometer. Descriptive statistics were produced for pertinent variables as well as a regression analysis of cloud thickness in relation to cloud liquid water content. The results of these tests indicate that cloud thickness and cloud liquid water content are highly correlated, and that a straight line model describes this relationship.

ANAEROBIC DEGRADATION PRODUCTS OF TOLUENE AND LABORATORY MSDS MANAGEMENT

Lydia Ruth Strickland
A.C. Mosley High School

Abstract

As a student in the High School Apprentice Program I found it to be a great learning experience. During the summer I organized the entire laboratories Material Safety Data Sheets into one master set. The six different labs contained their own sets of MSDS's and it was my responsibility to put them together. I assigned all 5,600 chemicals their own reference number for easier access to locate MSDS's. Also in my curriculum for the summer I tested contaminated groundwater to see if it contained a chemical called benzylsuccinic acid. This is a byproduct of organisms that eat the main ingredient in the jet fuel that contaminated the groundwater. I found this summers job to be a excellent opportunity for students like myself.

THE PROCESS OF TECHNICAL PUBLICATION/DOCUMENTATION VIA ELECTRONIC MEDIA FOR THE ARMSTRONG LABORATORY

Rachel Strickland
A.C. Mosley High School

Abstract

The participation of working at Armstrong Laboratory has been a learning experience. The Programs and Plans Department supports the laboratory in the technical documentation part of the laboratory. Technical reports are an important part of the process of publication of the experiments conducted at Armstrong Laboratories. This department also does the marketing which is done with pamphlets and booklets distributed during conferences and seminars. Also, a photo file was established to help organize pictures what the scientists were engaged in with their experiments. The most educational part of the summer was in researching the Environmental Protection Agency 17 Industrial Toxins Project Chemicals. This is a list of health hazardous toxins was researched and a large of amount of useful information was found on the subject. This summer has been an experience that has helped to better understanding of what is offered in the work force. Many business skills have been learned that can help later in a business environment.

A STUDY OF THE EFFECTS OF THE PERFORMANCE OF POLYMER DISPERSED LIQUID CRYSTAL HOLOGRAPHIC GRATINGS WITH VARYING EXPOSURE ENERGIES

Kari D. Sutherland
Dayton Christian High School

Abstract

The focus of this experiment was to study the effects of the performance of polymer dispersed liquid crystal gratings using varying exposure energies and to find if the chemical reaction continues after exposure for some time. Exposure times of 15 seconds to 3 minutes with 15 second increments were chosen. Samples were constructed and exposed for the different exposure times by an Argon Ion laser of 514 nm. After exposing, an experiment was set up using a helium neon laser at 633nm to measure the diffraction efficiency of each sample. Switching voltage was done to compare the results with the diffraction efficiency. The diffraction efficiency continued to increase until the exposure time between 75 and 90 seconds was reached. At that point it began to level off. Voltage switching began to occur with the sample of 75 second exposure time. The switching of the higher exposure times had similar results thus agreeing with the conclusion that the refractive index modulation due to the phase separation of PDLC droplets reaches a maximum between 75 and 90 seconds and remains there independent of the exposure energy.

A STUDY OF THE CORROSION RESISTENCE
OF SOL-GELS

Rebecca M. Thien
Chaminade Julienne High School

Abstract

The corrosion resistance of aluminum that was previously coated with a sol-gel with and without inhibitors was studied. The two inhibitors used were sodium molybdate and sodium sebacate. The corrosion resistance of aluminum in solutions containing these inhibitors was also studied. The sol-gel was dip-coated onto 2" by 1" 2024-T3 aluminum slides. These samples were then tested using Tafel analysis and Potentiodynamic Scans. The results of the experiment showed that sol-gels could be used as corrosion prevention coatings. However, the two inhibitors, sodium molybdate and sodium sebacate, did not improve the corrosion resistance of the sol-gel when they were added.

Maintenance of Facilities

Daniel M. Thompson
Tennessee Technological University

Abstract

The predictive and preventive maintenance program of Arnold Engineering and

Development Center was studied. To a certain extent, it was re-organized, so that the

maintenance schedule was made more accurate. The database program *Microsoft Access* was

used to temporarily store and edit the large amounts of data from previous maintenance records.

DATA REDUCTION FOR BLAST ARENA
LETHALITY ENHANCEMENT

Jonathan D. Tidwell

Rocky Bayou Christian School

Abstract

Data from blast arena testing of three high explosive (HE) formulations was reduced. The three formulations tested were APET-257e3, AFX-757, and PBXN-111 with the purpose of determining the blast performance of these specific formulations in a 1000 lb. MK-83 warhead. Data from the shots will be compared to data from previous blast arena testing conducted by the Air Force and the Navy on the BLU-110 (MK-83 with a PBXN-109 fill). The objective of the testing is to determine the performance gains realized by replacing the standard fill with current generation explosive technology. The overall goal of the program is to achieve 75 percent of the blast performance of the MK-84 (2000 lb. warhead).

THE EFFECT OF HYPERBARIC OXYGENATION
ON THE MITOTIC DIVISION OF PROSTATE CANCER CELLS

Kelly Todd
Theodore Roosevelt High School

Abstract

Prostate cancer is the most commonly diagnosed malignancy behind skin cancer. It is also the second leading cause of cancer death in U.S. men. Prostate cancer in its advanced stages is currently untreatable, thus there is a critical need for an effective treatment. For the experiment, malignant PC-3 cells were treated with hyperbaric oxygenation. It was hypothesized that the hyperbaric oxygen exposure will slow the growth rate of the cancer cells by stalling mitotic division. Effects of various pressure treatments ranging from 6 ATM to 0.32 ATM were tested. Experimental results indicated that .32 ATM was the most effective.

THE CHARACTERIZATION OF A
SCUD FRAGMENT

Robert L. Todd
Carroll High School

Abstract

The characterization of the metal used to fabricate a scud missile was determined. Samples of the scud fragment were cut, polished, magnified under an optical microscope and a scanning electron microscope, and tested for a chemical analysis. The results of the obersvation determined that there was a weld in the scud fragment. The microstructure of the weld looks like ferrite. The microstruction of the base metal looks like that of a duplex stainless steel. The chemistry of the scud fragment is typically that of a duplex stainless steel. The scud fragment was magnetic indicating the presence of ferrite, but because the specimen did not etch easily there is also a presence of austenite. The results proved that the scud fragment's metal was composed of a duplex stainless steel.

OPTICALLY ADDRESSED SPATIAL LIGHT MODULATORS
AS REAL-TIME HOLOGRAPHIC MEDIA

Nhi T. Tran
Manzano High School

Abstract

An optically addressed spatial light modulator (OASLM) and its effects on a compensated imaging

process using real-time holography were studied. Use of a spatial light modulator to improve efficiency of real-

time adaptive optical corrective techniques for telescope and atmospheric-induced path aberrations is significant

because it makes the development of large, lightweight, low-optical-quality primary mirrors possible.

A STUDY OF THE APPLICATION, USES, AND PERFORMANCE OF SPREAD SPECTRUM TECHNOLOGY IN DIGITAL SIGNAL PROCESSING

Brian Tuch
RL/IRAA
Brown University

Abstract

This study included exploration into Digital Signal Processing(DSP). While the focus of the experiment was on the use of spread spectrum technology, much time was spent learning basic techniques in MATLAB® and the fundamentals and mathematics behind DSP. To test the abilities of spread spectrum two scripts, one containing spread spectrum and the other not, were designed to simulate transmission and reception of a message. The results of both simulations prove the general utility of spread spectrum technology.

CEREBRAL HEMODYNAMIC RESPONSE
TO A SQUAT-STAND AT 1G

Tammy L. Venema
Walter E. Stebbins High School

Abstract

Introduction: The squat-stand test was used as an orthostatic tolerance test by simulating the physiological effects an individual would experience in a high-G environment. A cerebral oximeter was used to test the hypothesis that the cerebral oxygen saturation and relative cerebral blood volume would decrease significantly when moving from a squatting to standing position. Methods: The subjects were instrumented with a cerebral oximeter and then asked to squat for four minutes followed by a two-minute stand. The cerebral oximeter used near-infrared light to measure the difference in specific wavelengths of the absorption of oxygenated and deoxygenated blood. A formula was then used to calculate the relative cerebral blood volume changes experienced. Results: The results indicated that an insignificant relative cerebral blood volume change occurred when the subjects moved from the squatting to standing position. Conclusions: The females in this study were capable of making physiological adaptations so that the loss of cerebral blood volume was insignificant.

A Study of Psycho-Physiological Effects on Brainwave Activity During Varying Levels of Activity

Max P. Vilimpoc
Beavercreek High School

Abstract

Recent advancements in flight technologies and the developments of newer technologies for use in upcoming generations of fighter aircraft have spawned the need for a greater understanding of the human factor in airplane flight. Increasing amounts of information surround the jet fighter pilots of today, adding to the levels of stress they face while flying the aircraft. The purpose of this study is to determine which levels of stress trigger certain types of brainwave activity, and demonstrate two key techniques which are used by researchers to better understand and predict the nature of brainwaves.

THE EFFECT OF HYPERBARIC OXYGENATION
ON THE MITOTIC DIVISION OF PROSTATE CANCER CELLS

Elizabeth Walker
Theodore Roosevelt High School

Abstract

Prostate cancer is the most commonly diagnosed malignancy behind skin cancer. It is also the second leading cause of cancer death in U.S. men. Prostate cancer in its advanced stages is currently untreatable, thus there is a critical need for an effective treatment. For the experiment, malignant PC-3 cells were treated with hyperbaric oxygenation. It was hypothesized that the hyperbaric oxygen exposure will slow the growth rate of the cancer cells by stalling mitotic division. Effects of various pressure treatments ranging from 6 ATM to 0.32 ATM were tested. Experimental results indicated that .32 ATM was the most effective.

CONCEPT VS. REALITY:
DEVELOPING A THEORETICAL SEQUENCING
PROGRAM FOR SHOCK INDUCED COMBUSTION

Elizabeth A. Walker
Niceville Senior High School

Abstract

Studying high-enthalpy flow conditions has significant applications in high-speed flight and missile aerodynamics. Understanding this flow is important for interpreting experimental data and designing more effective advanced vehicles and testing techniques. A mathematical sequencing program was developed for determining the variable thermodynamic coefficients for shock induced combustion given initial conditions. The program can quickly produce data by simply changing these few conditions, and a x-t diagram (including the shock front, contact surface, rarefaction head and tail, and the expansion curve), pressure curve and temperature distribution for two pressure probes, and a contour plot of p2 are all graphed.

WEB BASED COMPUTER PROGRAMMING

Brian S. Walsh

Whitesboro Central School

Abstract

The concept of web based computer programming is becoming increasingly important. As the popularity and use of the World Wide Web (WWW)grows, so does the need for people who can program for it. Web based computer programming entails knowing Hypertext Markup Language (HTML), and other various computer programming languages such as Perl, Java, C, etc. Text is written in such a way so that it is like a list of written instructions for the computer to perform. It is up to the programmer's tastes and preferences on how he/she would like to perform the task.

A STUDY OF THE TENSION
AND SHEAR STRENGTH OF
BIDIRECTIONAL E-GLASS EPOXY-RESIN
COMPOSITES

Darren Wells
Bellbrook High School

Abstract

The tensile strength, shear strength, and water absorption of bidirectional E-glass epoxy-resin composites was studied. To undertake this study, 8"x8" squares of bi-directional E-glass fabric were used with various lay-up procedures, epoxy-resins, and curing procedures to produce a variety of composites roughly 7.5"x7.5" square. These composites were then cut into specimen seven inches long and of various width and thickness, depending on the testing. These specimens were tested in a Sintech materials testing machine to determine the composite's tensile and shear strength. This data allowed for the analysis of trends in the various composites commercially available.

Constructing a Computer Model of the Space Shuttle
and
The Effects of Lasers on Materials in Space

Jeremy White
Sandia Preparatory School

Abstract

The possibility of a space based war is ever increasing due to the advantages of carrying out certain tasks in space. It is important to have an accurate assessment of the situation in any war because it helps you to make important decisions during the battle, and these decisions can either help you win or loose the war. There is only one problem with using conventional methods of gathering intelligence information, and that is that they will not work. These methods will not work because they involve traveling to the target and observing the area, and that is not possible in space because it is so inaccessible. Satellites can be used to monitor the situation but visual information is still limited. That is why three dimensional modeling is being used, because there is always a visual representation that can be updated. Since the original is still available, the two images can be compared to more accurately assess the status of the target. Another thing that has to be considered is the use of lasers. Since they are such a new weapon, the effects are still being researched, but that information is needed in the case of a war, because if you don't know what a laser can do to an orbiting spacecraft, then you can't accurately judge the status of a target that has been under laser attack. It also helps one to know what you can do to an enemy spacecraft.

ACCESS CONVERSIONS

James R. Williamson
Franklin County High School

Abstract

AEDC runs an automated inventory tool to maintain an accurate description of its networked

PS's. This tool plays an integral role in the Year 2000 effort, which is tasked with determining the

compliance status of each PC as well as its software. The inventory tool, Norton Administrator, collects

the required data and stores it in a proprietary database. Other Year 2000 specific data was stored in a

Microsoft Access 7.0 database. It was necessary to merge the two files into a single database to provide

on-going reporting and status data. My task was the merging of these files and the development of

associated queries, forms, and reports.

Abstract

Anthropomorphic manikins are rigorously tested in both automotive and ejection seat testing. To properly simulate a human, these human surrogates should have proper centers of gravity (CG) and moments of inertia (MOI). The measurement and comparison of the CG and MOI properties of manikin segments was studied. The CG was measured using a scale and moment table while the MOI was measured using a mass properties instrument. This instrument is an inverted pendulum that measures periods of oscillations which can be computed to find the MOI along the principal and secondary axis. Afterwards, these measurements can be compared to similar manikin or human segments. Since it is not possible to use living human segments, regression equations have been developed through previous testing of cadavers and stereophotometry.

DEVELOPMENT OF ALGORITHMS TO OBJECTIVELY FORECAST PRESENT WEATHER AND SURFACE VISIBILITY BY MEANS OF A REGIONAL NUMERICAL MODEL- INDECISIVE APPROACHES

Joanne Wu

Newton North High School

Abstract

Three distinct statistical approaches to probabilistically weather forecast precipitation were studied: Perfect Prog, Model Output Statistics, and Modified Perfect Prog. Each of their respective advantages and disadvantages were weighed in terms of their effectiveness in the Present Weather/Surface Visibility algorithm development. The results of the study indicated that, although far from perfect, the Modified Prog approach was the most appropriate technique for the given application

THERMAL CHARACTERIZATION OF THE 1,3,3-TRINITROAZETIDINE (TNAZ)/ N-ACETYL-3,3-DINITROAZETIDINE (ADNAZ) BINARY MIXTURE

Tuan P. Yang

ABSTRACT

The binary phase diagram for the 1,3,3-trinitroazetidine (TNAZ)/N-Acetyl-3,3-dinitroazetidine (ADNAZ) system has been calculated computationally and determined experimentally. Initial physical mixtures of TNAZ and ADNAZ exhibit the thermal characteristics associated with a simple binary eutectic system, while remelt mixtures exhibit the characteristics associated with a simple linear solid solution system on the ADNAZ-rich side of the eutectic and a simple binary eutectic system on the TNAZ side. The calculated eutectic temperature/composition is 77.3°C/56.4 mol percent TNAZ. Neither TNAZ nor ADNAZ behave ideally in either type mixture.

REPRODUCING THE COPPER/GOLD EUTECTIC CURVE
USING COMPUTER SIMULATIONS

David A. Young
Rome Free Academy

Abstract

Dr. Helbig and I were interested in reproducing the Copper/Gold eutectic curve using only computer simulations. To accomplish this we used a computer program that simulates atoms' reactions to assumed interatomic forces and starting conditions. With this program we studied three different 1289-atom Wulff polyhedron systems (Copper, Gold, and a Copper/Gold eutectic alloy) to try to find the temperature at which each system melts. We used several different techniques to discover the most efficient way of determining the melting temperature. After weeks of trial and error with different methods we concluded that the method of increasing the temperature of the system very slowly while monitoring the root mean square displacement of the atoms from their original positions was the most effective way to determine the melting points in these systems. We experimented with this method to determine the surface melting temperature of these systems. We chose surface melting because the high temperatures needed for bulk melting caused evaporation. We determined that the surface melting temperature of a Copper/Gold polyhedron might be slightly below that of a pure copper system, although the temperatures of such small systems are intrinsically ill-defined.

DETECTION OF *CLOSTRIDIUM DIFFICILE* TOXINS BY POLYMERASE CHAIN REACTION

Muchieh Anne Yu
High School Apprentice
Theodore Roosevelt High School

Abstract

Clostridium difficile is an anaerobic prokaryote. It is a major cause of antibiotic-associated diarrhea and pseudomembranous colitis. *C. difficile* is one of the most commonly detected enteric pathogens and an important cause of nosocomial infections in hospitals and nursing homes. In most severe cases *Clostridium difficile* induced colitis can lead to death. The standard methods of diagnosing *Clostridium difficile* induced colitis are time consuming and lack specificity. Scientists and clinicians have called for polymerase chain reaction-based assay to detect gene encoding toxins A and B in stool samples.

IDASS ADDITIONS

Aaron Zimmerman
Sandia High School

Abstract

To create a user friendly, efficient, and overall more productive program, additions to Phillips Laboratory's Intelligence Data Analysis System for Spacecraft (IDASS) core program are needed. Two additions added during the 1997 summer are the ability to communicate and share data with Satellite Tool Kit (STK), by Analytical Graphics Inc., and the ability to receive data from telescope images of deep space satellites. These two additions allow the user a broader range of choices to complete the task desired. With the two additions to IDASS, the user, who may be in the intelligence field, who may be in charge of satellite development and tracking, or a casual or serious observer, will benefit greatly in productivity and efficiency.